Que.
ORIGIN STORAGE

PROVINCE OF QUEBEC, CANADA

Department of Colonization, Mines and Fisheries

MINES BRANCH

Honourable HONORÉ MERCIER, Minister :: S. DUFAULT, Deputy-Minister

THÉO. C. DENIS, Superintendent of Mines

TN
27
Q3A3
1915

REPORT ON

MINING OPERATIONS

IN THE

PROVINCE OF QUEBEC

DURING THE YEAR 1915

QUEBEC,
PRINTED BY E. E. CINQ-MARS,
PRINTER TO HIS MAJESTY THE KING.

1916

PROVINCE OF QUEBEC, CANADA

Department of Colonization, Mines and Fisheries

MINES BRANCH

Honourable HONORÉ MERCIER, Minister :: S. DUFAULT, Deputy-Minister

THÉO. C. DENIS, Superintendent of Mines

REPORT ON

MINING OPERATIONS

IN THE

PROVINCE OF QUEBEC

DURING THE YEAR 1915

QUEBEC,
PRINTED BY E. E. CINQ-MARS,
PRINTER TO HIS MAJESTY THE KING.

1916

Province of Quebec.

DEPARTMENT OF COLONIZATION, MINES AND FISHERIES.

To the Honourable Honoré Mercier,

Minister of Colonization, Mines and Fisheries,
Quebec.

Sir,—

I have the honour to submit the Annual Report on Mining Operations in the Province of Quebec during the year 1915, transmitted me by the Assistant Superintendent of Mines.

I have the honour to be,

Sir,

Your obedient servant,

S. DUFAULT,

Deputy Minister.

Quebec, June 9th, 1916.

Province of Quebec.

DEPARTMENT OF COLONIZATION, MINES AND FISHERIES.

MINES BRANCH

S. DUFAULT, ESQ.,
Deputy Minister of Colonization, Mines and Fisheries.

DEAR SIR,—

As is customary at this date, I have the pleasure of submitting to you the Annual Report on Mining Operations for the year ended 31st December, 1915.

Owing to the absence of Mr. T. C. Denis, Superintendent of Mines, who as a reservist of the French army, was called to the colours about the middle of March, to join his regiment, the task of compiling this report devolved upon his assistant.

The figures showing the mineral production, given on page 9 having been revised, they must be substituted for those given in the preliminary report of mining statistics, published on the 22nd February last.

Following the statistics, the development of the mineral industry and the chapter on accidents, will be found a report on the economic geology of a portion of the county of Portneuf, comprising the townships of Chavigny and Montauban and a portion of the seigniory of Grondines, by Dr. J. A. Bancroft.

Yours very obediently,

A. O. DUFRESNE,
Assistant Superintendent of Mines.

Quebec, 9th June, 1916.

TABLE OF CONTENTS.

	Pages
Letters of transmittal	3, 4
Note	6
Statistical Review	7
Table of mineral production	9
Legislation	10
Chemical laboratory	11
Inspection of mines	14
Field work	14
War measures	17
Mining operations—	
Asbestos	18
Copper	26
Gold and silver	28
Zinc and lead	29
Iron	32
Mineral paints	32
Chromite	33
Molybdenite	36
Graphite	38
Feldspar	38
Mica	38
Kaolin	39
Magnesite	42
Mineral Water	44
Building materials	45
Natural gas	47
List of mine and quarry operators	49
Accidents in mines and quarries	67
Storage of explosives	95
Thawing of explosives	99
Report on the geology of the zinc and lead deposits of the county of Portneuf	103

NOTE.

In the statistical tables and in the review of the mining industry of the province during the year, the term "production" is synonymous with "quantity sold or shipped," and does not necessarily represent "output." The ore, and other mineral products remaining as "Stock on hand" at the end of the year, are not included in the production figures.

The ton used throughout is that of 2,000 lbs., except when specially mentioned.

The year referred to is the calendar year, ending December 31st, unless specially stated.

We endeavour to give values of the mineral products, raw or manufactured, as estimated at the point of shipment or at the pit-mouth; this, however, is sometimes difficult to obtain.

MINING OPERATIONS

IN

THE PROVINCE OF QUEBEC

DURING THE CALENDAR YEAR 1915*

STATISTICAL REVIEW

As was to be expected the mining industry of the Province of Quebec felt, during the years 1914 and 1915, the effects of the war on the commercial relations between the various countries. Such effects were beneficial in some instances and detrimental in others.

America, which obtained from Europe its supplies of much of the raw material required for its industries, found its commercial relations greatly hampered either because the means of communication were interrupted through the European situation, or because ocean freight rates had become prohibitive, while it was also impossible to obtain the necessary cargo space. This situation created a demand which resulted in an active resumption of work on our chromic iron deposits and the development of operations in the magnesite quarries of the county of Argenteuil.

Moreover the high prices of metals which have gradually risen during the past eighteen months, greatly stimulated the working of our mines of copper pyrites, of zinc and lead, while owners of molybdenite deposits were encouraged to work them.

All such activity, which has resulted in a marked increase in mineral production, will not merely have given a passing impetus to Quebec's mining industry, it is almost certain that, when the war is over, the operations of some companies will continue and assume a permanent character.

---

*Translated from the French by Mr. Crawford Lindsay, with the exception of the report by Dr. J. A. Bancroft, of which the original is the English version.

The fact must not be overlooked that the value of building materials, stone, lime, cement and bricks constitute the greater portion of our mineral production and the decrease in the value of such products must be attributed to the abnormal economic conditions that have prevailed during the past two years.

The total of our mineral production has consequently been affected but we confidently look forward to a change in the near future and we shall then witness yearly increases in the value of the products of the mines and quarries of the Province of Quebec.

The compilation of the reports of the production of mines and quarries, sent directly to the Mines Branch, show a total value of $11,465,873 for the year ended 31st December, 1915. This is a decrease of $266,910 or 2% as compared with the previous year, the total figures for which were also lower than those for 1913.

In 1915, the products of the mines, properly so called, comprising metallic minerals, asbestos, magnesite, graphite, etc., reached a total of $5,223,639, being an increase of 32% over the year 1914. Building materials: stone, bricks, cement, etc., give a total of $6,242,234, being a decrease of about 20%.

To enable those who are interested in the matter to form an idea of the development of the mining industry in the Province of Quebec, we give below a table of the production during the past twelve years:—

Year	Value
1904	$ 3,023,568
1905	3,750,300
1906	5,019,932
1907	5,391,368
1908	5,458,998
1909	5,552,062
1910	7,323,281
1911	8,679,786
1912	11,187,110
1913	13,119,811
1914	11,732,783
1915	11,465,873

TABLE OF MINERAL PRODUCTION OF THE PROVINCE OF QUEBEC DURING 1915

Substances	Numberof Workmen	Salaries	Quant'es	Value	Value in 1914
		$		$	$
Asbestos, tons	2,432	1,093,281	113,115	3,544,362	2,895,935
Asbestic, tons	.....	.....	25,000	21,819	4,904
Chromite, tons	211	106,794	14,397	245,297	1,210
Copper and Sulphur ore, tons	306	190,326	142,797	1,021,777	801,129
Feldspar, tons	.....	.....	32	640	2,156
Gold, ozs	5	300	1,158	23,082	21,064
Graphite, lbs	12	1,601	135,200	2,461	18,886
Kaolin, tons	27	17,000	1,300	13,000	9,000
Magnesite, tons	150	25,607	16,285	137,353	2,240
Mica, lbs	116	27,552	735,602	55,897	67,278
Mineral Water, gals	56	15,526	358,275	33,084	23,569
Mineral Paint (ochre) tons	43	17,012	6,264	42,285	36,600
Phonolith and glass sand, tons	19	2,494	4,000	8,000	2,114
Phosphate, tons	6	300	200	2,400	5,057
Silver, oz	.....	.....	72,809	36,182	31,809
Zinc and lead ores, tons	47	21,932	634	36,000	10,017
STRUCTURAL MATERIALS:					
Brick, M	789	249,652	91,932	655,017	1,094,531
Cement, bbls	460	355,513	2,484,362	2,805,374	3,325,055
Granite	528	220,102	.....	269,350	582,235
Lime, bushels	209	79,831	1,209,695	228,670	391,622
Limestone and Marble	2,157	844,954	.....	1,830,141	1,745,855
Sand	163	33,070	.....	210,809	446,532
Sandstone	73	30,076	.....	35,754	.....
Slate, sq	20	5,520	397	2,039	5,105
Tile, drain and sewer pipe, pottery	160	81,414	.....	195,080	208,355
	7,989	$3,419,857		$11,465,873	$11,732,783

LEGISLATION

Several amendments were made to the Mining Act during the past session of the Provincial Legislature, the most important whereof are as follows:

Article 2106 of the Revised Statutes, 1909, was amended so as to allow of mining rights being obtained, by letters patent, on half lots in surveyed townships while previously the same rights could be acquired for whole lots only. As the latter were often of much larger area than was required for mining purposes, the purchaser was obliged to incur needless expense. He may now obtain rights on half lots provided their area is at least forty acres.

Article 2192 now reads as follows:

"*2192. Every person who commences to operate a mine or quarry, or who, after a suspension of six months, resumes operations already begun by himself or by others, is bound, under penalty of a fine of not more than twenty-five dollars, and costs, and, in default of payment, to imprisonment for not more than one month, to give to the Minister a notice in writing, setting forth:*

1. The name and address of the person carrying on the operations;

2. The locality and the description of the land on which such operations are carried on;

3. The nature of the ore or mineral which is the object of the operations."

We wish particularly to call the attention of persons interested in the working of mines and quarries in the Province of Quebec to the foregoing article. It is essential for the needs of inspection of mines and quarries, from the standpoint of the safety of the workmen and also for accuracy of the figures of the statistics, that the Bureau of Mines be notified at the very beginning of the working of mineral deposits and stone quarries, and also when work is resumed in old mines which have been closed down for a period exceeding six months.

Moreover, mine and quarry operators must send a full report of their production to the Bureau of Mines at the beginning of each year. Article 2163 of the Quebec Mining Act says very clearly that: "*every owner of mining rights, whether he mines himself or by others, and every person working mines shall, during the first ten days of January in each year, furnish a sworn statement of his operations for the past year, mentioning the quantity of mineral extracted, its value at the mine, the quantity and value of the marketable product and the number of workmen employed, as well as a list of the names of the persons killed or injured in working the mines.*"

The penalty for non-compliance with the above article is $20 "for every day on which such offence occurs, continues or is repeated," and, in default of payment, imprisonment for not more than one month.

Although the great majority of operators are prompt in complying with the law there are unfortunately some dilatory ones who, by putting off the sending of the report of their production, needlessly delay the final publication of statistics of mineral production.

It is proper that people should know that the individual figures of production reported to the Bureau of Mines are considered confidential and are used solely for compiling the totals and calculating averages.

CHEMICAL LABORATORY

The Quebec Mines Branch maintains at the Polytechnic School, 228 St. Denis Street, Montreal, an up-to-date, well-equipped assay and chemical laboratory, for the convenience of the interested public. Analyses and assays, determinations of mineral specimens and tests of various kinds of ore, samples and materials found within the boundaries of the Province of Quebec, are made in this laboratory at prices which are extremely low for the high-grade work done. The laboratory has been installed for the sole purpose of aiding the development of the mineral industry of the Province of Quebec.

Prospectors and all persons interested in the Quebec mineral resources are cordially invited to avail themselves of the facilities offered. The tariff in force for the analysis and assay of various substances is given further on, and it will be realized that the fees are very low, as the high competence of the chemists insure results of undoubted reliability.

During the year ended 31st December, 1915, the number of analyses and assays made at the provincial laboratory was as follows:

Gold, 174; silver, 69; aluminium, 6; arsenic, 2; carbon (graphite), 4; lime, 41; chromium, 9; copper, 43; iron, 29; fluorine, 1; magnesium, 37; molybdenum, 4; nickel, 19; phosphorus, 2; platinum, 1; potassium, 1; silicon, 28; soda, 1; sulphur, 28; titanium, 2; uranium, 3; radioactivity, 3; loss by fire, 3; technical information, 1; qualitative determinations of metals, 62; identifications of minerals, 36.

PROVINCE OF QUEBEC

GOVERNMENT ASSAY LABORATORY

(Under the direction of the Department of Mines of the Province of Quebec as an aid to the development of the mineral resources.)

TARIFF OF FEES FOR ASSAYS AND ANALYSES

DETERMINATIONS	Less than 5 samples Each:	For 5 samples or more Each:
	$ Cts.	$ Cts.
Moisture	0.25	0.25
Combined Water	0.50	0.50
Gold and Silver	1.00	0.90
Silica, Copper, Iron — 1 constituent	1.00	0.90
Silica, Copper, Iron — 2 constituents in same sample	1.75	1.50
Iron, in titaniferous ore	2.00	1.80
Alumina, Cobalt, Graphite, Lead, Lime, Magnesia, Nickel, Sulphur — 1 constituent	1.50	1.35
Alumina, Cobalt, Graphite, Lead, Lime, Magnesia, Nickel, Sulphur — 2 constituents in same sample	2.50	2.25
Antimony, Arsenic, Bismuth, Chromium, Manganese, Molybdenum, Phosphorus, Platinum, Titanium, Zinc — 1 constitent	2.00	1.80
Antimony, Arsenic, Bismuth, Chromium, Manganese, Molybdenum, Phosphorus, Platinum, Titanium, Zinc — 2 constituents in same sample	3.50	3.15
Commercial analysis of an iron ore, comprising determination of silica, iron, phosphorus, titanium and sulphur	6.50	5.85
Commercial analysis of a limestone or cement, comprising silica, lime, iron, alumina, magnesia, and sulphuric acid	6.00	5.40
Commercial analysis (proximate analysis) of a fuel, comprising: ash, volatile combustible, fixed carbon, moisture	3.00	2.70
Calorific power of a fuel	1.50	1.35
Radioactivity of a mineral	1.00	0.90
Radioactivity of a mineral water	2.00	1.80

Determination of Minerals.—For a nominal fee of 25c for each sample, the laboratory will make determinations of ores and minerals, provided rapid tests will allow it, and issue a report on probable contents and commercial value of specimens and samples.

Terms.—Money in payment of fees, by registered letter, postal notes or orders, must invariably accompany the samples, in order to insure prompt return of certificate.

Professor E. DULIEUX,
In charge of Laboratory
No. 228 St. Denis St.,
Montreal.

INSPECTION OF MINES

The inspection of mines was carried on as regularly as the time at the inspectors' disposal permitted. Mr. A. O. Dufresne, the assistant superintendent of mines, was specially charged with that duty. Particular attention was given to mines in regular operation. Only one visit was made to quarries. It is gratifying to note that marked progress has been made in putting precautionary measures against accidents into practice. The Bureau of Mines has endeavoured to make out as complete statistics of accidents as possible. Annexed to that part of the report which deals with "accidents in mines," will be found two lists of the fatal and non-fatal accidents in the mines and quarries of the Province of Quebec during the year 1915.

Since the publication of the last report, the following regulations have been added by order-in-council to those already enacted by the Lieutenant-Governor-in-Council in connection with health and safety in mining work.

Re.—Scaling of Workings

The walls, roofs of shafts, levels, stopes, tunnels, raises and other underground parts of mine workings, the sides and walls of open-cast pits, quarries, sand and clay pits, and all other workings of mines and prospects, must be scaled and freed of loose or fissured rocks and stones, so as to ensure the safety of the workmen.

Re.—Explosives

All firing of blasts in the course of shaft sinking shall be done by electricity.

A charge of explosives, whether it is a missed hole or a charge which has not been fired, shall not be withdrawn.

FIELD WORK

The interesting discoveries of zinc and lead deposits made in the township of Montauban, county of Portneuf, induced the Bureau of Mines to have a detailed study made of the geology of that

district. The work was entrusted to Dr. J. A. Bancroft, Professor of Geology at McGill University. During the two months he was in the field, he went over the townships of Montauban and Chavigny and the adjacent portion of the seigniory of Grondines. The results of his work are set forth in a report which will be found at the end of this volume with a geological map showing the distribution of the geological formations he found.

During the year 1915, in addition to the preliminary report giving the statistics of mineral production for 1915, and the yearly report for the year 1914, which came out at the end of the month of May, the Bureau of Mines published an interesting work, covering 295 pages, on the copper deposits of the Eastern Townships of the Province of Quebec by Dr. J. A. Bancroft, being the result of two seasons' field work.

The report includes historical notes on the mining of the copper deposits in that part of the province; the second chapter is devoted to the general geology of such deposits; each mine and each occurrence where close examinations have been made, are the objects of thorough study. The volume also contains several plates and sketches, and a map of the district.

The necessity of giving accurate information respecting that portion of the country now known as "New Quebec," and the desire of the public to learn about that vast region led the Bureau of Mines to reprint the volume entitled "Extracts from reports on the District of Ungava recently annexed to the Province of Quebec under the name of the Territory of New Quebec." The first edition of the work, which was published in 1912, was out of print.

The iron deposits of the province investigated by Professor P. E. Dulieux during the summers of 1911 and 1912 were also the subject of a special report published in French, entitled: "Les Minerais de fer de la Province de Quebec." It contains a description of the deposits with information respecting their development and utilization. That volume, like the previous ones, contains several illustrations. The results of the field work of Prof. Dulieux may be found in the English version of the Annual Report of 1911 and 1912.

At the end of February of this year, the Bureau of Mines distributed a preliminary table, with notes, giving the statistics of the

mineral production of the Province for the year ended 31st December, 1915.

The Geological Survey of Canada has had certain portions of the Province of Quebec under investigation, the results of which have been published in the following volumes: Memoir 64—Preliminary Report on the Clay and Shale Deposits of the Province of Quebec, by J. Keele; Memoir 72—The Artesian Wells of Montreal, by C. L. Cummings; Memoir 73—The Pleistocene and Recent Deposits of the Island of Montreal, by J. Stansfield; Memoir 81—The Oil and Gas Fields of Ontario and Quebec, by Wyatt Malcolm.

The Federal Mines Branch, published some works, during the year 1914, on the mineral resources of the province of Quebec, and called the attention of those who may be interested in the matter to them.

In the summary report for the year 1914 we find an abstract of a report on the limestones of the Province of Quebec by Mr. Howell Fréchette. The object of investigation was to ascertain the economic importance of the limestones of this province and their applicability to the various uses made of them by industry in general. The districts gone over in 1914 were those between Bryson and Quyon; Hull and vicinity; the Gatineau Valley between Wakefield and Aylwin; Buckingham and vicinity; the county of Argenteuil; St. Thérèse and vicinity; Montreal and vicinity; also the district south of a line running through Valleyfield, Beloeil, St. Hyacinthe, Drummondville and d'Israeli. Among other information contained in the abstract published in the summary report, are several chemical analyses of limestones.

With a view to determining their utilization in connection with building and manufactures, Mr. Heber Cole was instructed to report on the sands and sandstones of the Province of Quebec. Special investigations were made for the purpose of finding sands which can be used in glassmaking and as foundry sand. The sections of the province where such examinations were made are those comprised between the St. Lawrence and Ottawa rivers and the eastern boundary of the Province of Ontario; those north of the St. Lawrence and Ottawa rivers from a point seven miles west of Lachute to Grand'Mère, along the St. Lawrence between Montreal and Quebec.

The ore-dressing laboratory of the Mines Branch, Ottawa, made a study during the year 1914, of the concentration of the following ores of the Province of Quebec: serpentine containing asbestos and chromite; zinc concentrates from the mines at Notre Dame, county of Portneuf; zinc lead copper ore from the Laurentide Mining Company, Notre Dame des Anges, and also of the magnetic iron sands of Natashquan, county of Sagnenay.

The peat-bogs of the Province of Quebec were also studied by Mr. Alph. von Anrep.

WAR MEASURES

Various orders-in-council have been issued by the Government of the Dominion of Canada since the outbreak of hostilities in Europe, prohibiting the exportation of certain Canadian products to certain countries.

We give below an extract from such orders-in-council, mentioning only the mineral products in which the Province of Quebec is interested.

(a)—It is forbidden to export mica, micanite, apatite, and phosphate of lime to any country other than to the United Kindgom, British possessions and protectorates, France, Russia (except Baltic ports), Japan, the United States and Italy, when such articles are to be consumed in such country or shipped to consignees in the United Kingdom through the United States or are exported via the United States under a license or permit from Canada.

(b)—It is forbidden to export the other articles mentioned below to any country other than the United Kingdom or British possessions and protectorates, namely: asbestos, graphite, molybdenite, chrome ore, lead ore, manganese ore, zinc ore.

(c)—It is forbidden to export copper ore, iron ore, iron pyrites to any foreign port in Europe and in the Mediterranean and Black Sea, other than France, Russia (except Baltic ports), Belgium, Spain, Portugal and Italy.

Operators producing such substances may, however, in certain cases, obtain a special export permit from the Customs Department at Ottawa.

Under this provision, the greater portion of our asbestos, chrome ore, lead, zinc and copper was shipped to the United States.

ASBESTOS

Eight companies operated asbestos mines during the year 1915, namely: The Asbestos and Asbestic Co.; Asbestos Corporation of Canada, Limited, worked the King, the Beaver, and the British Canadian mines; B. & A. Asbestos Company; Bell Asbestos Mines; Black Lake Asbestos and Chrome Co. Limited, (two mines); Jacobs Asbestos Mining Co.; Johnson's Co.; The Martin-Bennett Asbestos Mines Limited.

We note a slight increase in the total quantity of asbestos-rock mined: 2,134,073 tons as against 2,127,395 in 1914.

The asbestos milled from such rock was valued at a total amount of $3,544,362, being an increase of 22% over the sales in 1914. The year 1915 did not, however, show an excess in the quantity of rock mined and in the value of asbestos, over 1913, which holds the record for the production of that substance, as may be seen by a comparison of the tables below. On the other hand the average value per ton, $31.33, for 1915 exceeds that for 1913.

During the first months of last year the Jacobs and British Canadian mines suspended operations; most of the other mines worked only to 30% or 50% of their capacity.

Such temporary suspension, which dated from the beginning of the European war, was caused by the closing of the German markets and the scarcity of ocean freight on steamers running between America and Europe, and this continued until asbestos was required for the manufacture of war munitions. On the other hand, the great demand by American manufacturers since last spring has done away with the uneasiness that paralyzed this Quebec industry.

It is interesting to observe that the demand for the better qualities of asbestos was greater in 1915 than in any previous year, while the largest quantity of the inferior qualities sold was in 1913, when building was more active. As everybody is aware, large quantities of asbestos are used in building operations in the shape of boards or shingles for the outside of buildings. A large quantity is also used as boiler and pipe coverings. The better qualities are chiefly used in manufacture of incombustible fabrics.

Production of Asbestos in the Province of Quebec in 1915

Designation of Grade	Shipments			Stock on Hand	
	Tons	Value	Average value per ton	Tons	Value
Long Fibre, Crude No. 1	2,734	$750,112	$274.36	590	$176,523
Long Fibre, Crude No. 2	2,631	322,048	122.44	300	41,582
Mill Stock No. 1	12,502	804,193	64.32	290	50,294
Mill Stock No. 2	36,945	981,890	26.84	5,525	157,012
Mill Stock No. 3	58,303	686,119	12.57	15,333	240,800
	113,115	3,544,362	31.33	22,038	666,211
Asbestic	25,000	21,819			
Totals	138,115	3,566,181			

Quantity of rock mined during the year, 1915, 2,134,073tons.

Production of Asbestos for 1914

Designation of Grade	Shipments			Stock on Hand	
	Tons	Value	Average value per ton	Tons	Value
Crude No. 1	1,336	$ 402,417	$301.96	985	$301,237
Crude No. 2	2,812	370,776	131.85	1,345	187,688
Mill Stock No. 1	10,485	633,289	60.40	2,737	166,761
Mill Stock No. 2	32,847	818,765	24.93	9,757	231,874
Mill Stock No. 3	59,921	670,688	11.18	16,968	204,429
Totals	107,401	2,895,935	26.96	31,792	$1,091,989
Asbestic	13,251	4,904			
	120,652	2,900,839			

Quantity of rock mined during year 1914, 2,127,395 tons

PRODUCTION OF ASBESTOS FOR 1913

Designation of Grade	Shipments			Stock on Hand	
	Tons	Value	Average value per ton	Tons	Value
Crude No. 1	2,140	$588,310	$275.00	880	$247,787
Crude No. 2	2,870	384,559	134.00	1,522	178,767
Mill Stock No. 1	14,056	829,440	59.00	4,545	278,374
Mill Stock No. 2	29,525	817,963	27.75	3,862	121,545
Mill Stock No. 3	88,018	1,210,232	13.75	9,932	112,825
Totals	136,609	$3,830,504	$28.04	20,741	$939,298

Quantity of rock mined during year 1913, 2,527,410 tons.

PRODUCTION OF ASBESTOS FOR 1912

Designation of Grade	Shipments			Stock on Hand	
	Tons	Value	Average value per ton	Tons	Value
Crude No. 1	1,941	$510,785	$ 263.16	867	$221,215
Crude No. 2	3,766	379,445	100.76	2,867	310,596
Mill Stock No. 1	3,682	237,203	64.42	2,370	137,106
Mill Stock No. 2	32,689	1,018,960	31.17	8,234	301,774
Mill Stock No. 3	69,097	912,691	13.21	6,838	131,515
Totals	111,175	3,059,084	27.52	24,176	$1,102,206

Quantity of rock mined during year 1912, 1,870,608 tons.

No asbestos was shipped from outside the four districts of Asbestos, Black Lake, Thetford Mines and Robertson. Some prospecting was done on lots Nos. 5 and 6, range IV of Coleraine township by the Windsor Asbestos Company Limited and on lots Nos. 16 and 17, range I, Wotton township, by Mr. Leon Sohier for the Wotton Asbestos Company.

The table below shows the development of the asbestos industry in the Province of Quebec since 1903:

Year	Tons	Value
1903	29,261	$ 916,970
1904	35,479	1,186,970
1905	48,960	1,476,450
1906	61,675	2,143,653
1907	61,985	2,455,919
1908	65,157	2,551,596
1909	63,965	2,296,584
1910	80,605	2,667,829
1911	102,224	3,026,306
1912	111,175	3,059,084
1913	136,609	3,830,504
1914	107,401	2,895,935
1915	113,115	3,544,362

The production of asbestos in the Province of Quebec as shown in the detailed tables for the years 1912, 1913, 1914, 1915, is subdivided into two great classes; the long fibre (crude) is hand-cobbed and picked and there are two grades: No. 1 sells for $200.00 and over per ton, and No. 2 is valued under $200.00. For mill stock, that is the product of mechanical separation, we have adopted, for statistics, an arbitrary classification into three qualities $45 and over; between $45 and $20 and under $20 per ton. Counting the stock on hand at the beginning of 1915 valued at $1,091,989, the 2,134,073 tons mined gave an average yield of $1.46 of asbestos per ton of rock.

For the years 1912, 1913 and 1914 the average value was calculated at $1.38, $1.45 and $1.44 respectively.

The temporary suspension of operations did not affect the confidence of the directors of the various companies mining Canadian deposits in the ever increasing expansion of new uses of asbestos. The development of mining methods and the improvements of separating mills indicate progress. Considerable work is being done at most of the mines which will enable either a reduction to be made in the cost of mining per ton or saving to be

effected in the power required for driving the various machines, or will assure the regular working of the mill.

Thus, as will be seen in detail further on, the Asbestos Corporation of Canada at the King mine, has replaced the thirteen small cable-derricks by four powerful ones, and it is stated that a new crusher and a dryer will be in operation and a large storage bin will be installed. At the British Canadian mine, the ore will be hauled from the bottom of the pit to the mill head by tunnels and small railways. A new pit has been opened at the Beaver mine. At the Bell Asbestos Mines the mill is being re-organized; at the Jacobs mine, plans have been made for driving an inclined tunnel to reach the bottom of the open working, etc.

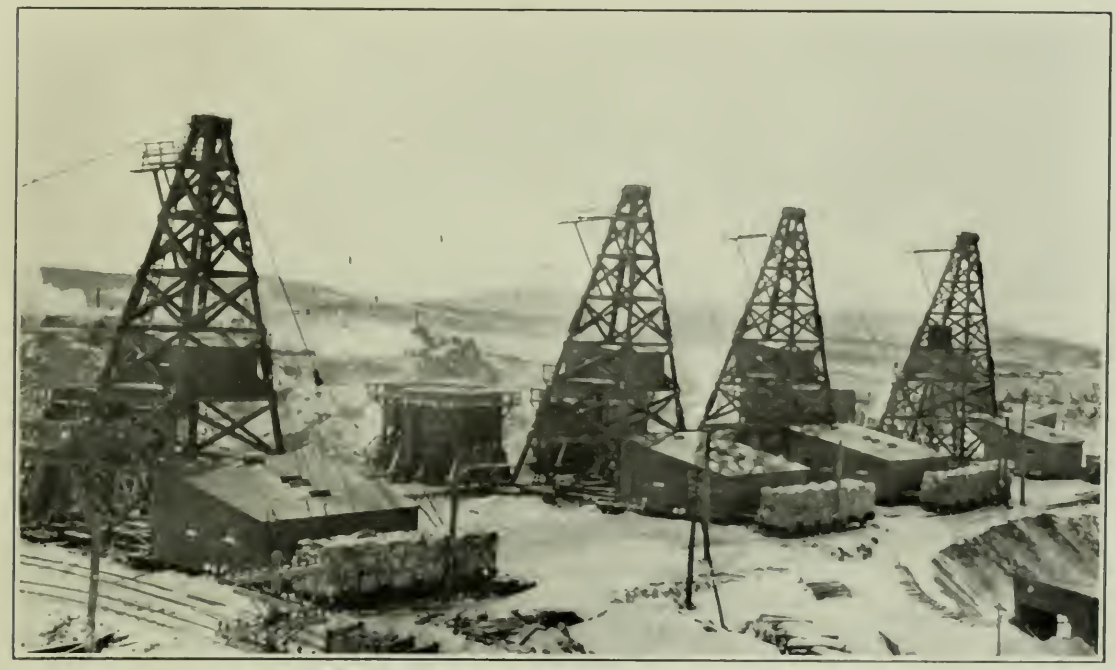
The scale of wages has greatly varied since the summer of 1914 when work was actively carried on in the asbestos mines. The breaking out of the European war which closed the German market to that product, the scarcity of transatlantic transport, added to the indecision of the American buyers, compelled several mines to curtail and even to suspend operations. Many workmen were without employment, at Black Lake only fathers of families could get a little work at wages not exceeding one dollar a day. In the spring workmen earned $1.25 and later on $1.40. In the spring of 1915, when the stock on hand had all been shipped, work was actively resumed and, after a very short strike at the end of October, 1915, wages were raised to $1.75 with a promise of an increase to $2.00 in the month of May, 1916.

In 1915, the 2,432 labourers working in the asbestos mines have received $1,093,281 in wages, while in 1914, the 3,054 men employed in this industry received $1,285,697, a diminution of 15%.

Of all the companies interested in asbestos mining, the *Asbestos Corporation of Canada* is making the most progress. At its mines, the King and British Canadian, is completely changing its mining methods, and it has opened a new pit at the Beaver mine. It has also made considerable alterations in its mills.

At the King mine, four powerful cable-derricks replace the thirteen small ones, a change which enables double the daily hoisting capacity. These four cable-derricks, stated to be the largest in the world, have each a steel cable 2½ inches in diameter, strongly anchored at each end under a mass of rock after passing over the

PLATE I.



King's Mine—Asbestos Corporation of Canada.
Head towers of new cable-der.icks.

PLATE II.

King's Mine—Asbestos Corporation of Canada.
Showing towers of new cable-derricks to the left and the supports of the old type of cable-derricks to the right; also new carriage in the centre of picture.

top of two towers 892 feet distant from one another. The head tower measures 78 feet and the other 45 feet in height; both are made of southern yellow pine. At the foot of the head tower is an electric hoist with three drums worked by a 225 H.P. induction motor provided with a solenoid brake. The engineer controls the machinery from a signal-box situate about the middle of the tower, where he receives orders directly from the gang foreman at the bottom of the pit.

The hoist lifts a total weight of 10 tons. The steel box is raised by cables three-quarters of an inch in diameter with a speed equal to one-third that of the traction speed 820 feet per minute. The box empties automatically into double bins of a capacity of one hundred tons of ore. By means of two hoppers the stone is loaded on cars which are hauled to the crushers by a locomotive.

The towers, hoist anchorage all rest on wheels running on rails so that the whole can be moved about very quickly and at slight expense. They are moved by means of a 22 H.P. induction motor installed at the foot of one of the towers.

To enable the mill to work independently from the mining, the company has put up a large storage bin in which the crushed and dried stone will be stored. A crusher of large capacity is being built and will probably be in operation at the end of the summer, 1916. To facilitate access to the bottom of the pit for the mine staff, the driving of a tunnel as far as the public road has been begun; its length will probably be 925 feet.

At the Beaver mine, to the west of the mill on the south side of the Q. C. R. track, systematic prospecting has resulted in locating a well mineralized zone where mining was begun during the autumn of 1915. This new open working, measuring from 300 to 400 feet in length, is called: "Pit No. 2 of the Beaver mine." The removal of the over burden, which is not deep there, has laid bare several asbestos veins, some of which are an inch wide. At some points on these veins, the presence of a slight streak of chrome iron is noticed. Two cable-derricks with hoists driven by a 75 H.P. induction motor have been installed. A railway 2,200 feet long has been built for conveying the asbestos-bearing rock to the mill.

At the British Canadian mine the Standard and Upper Works pits were worked during the few latter months of 1915. In open

working No. 2, at 35 feet from the bottom on the south side, they have begun driving a tunnel 10 x 12 feet, which is intended to be carried as far as under the Upper Works pit, a distance of 1400 feet. The tunnel will be connected with the open working by two shaft or winzes. When the work is finished the ore will be dropped into the shafts, at the lower end of which a hopper will load in the cars; these will run on a slightly inclined railway to the head of the mill. A short tunnel enables the cars to be loaded at the bottom of the Standard pit.

In the month of August last, the *Jacobs Asbestos Mining Co.*, whose operations had been suspended since the month of August, 1914, pumped out its pit and resumed work.

At the southern end, at the bottom of the open working, they have begun driving an inclined tunnel which will pass under the Q. C. R. railway track and come to the surface about 450 feet from the pit. This work forms part of a plan for the improvement of the mine.

The ore from the open working will be hauled to the dryers on the surface on that inclined plane. Encouraged by the discovery of fine veins of asbestos in the tunnel, the company has undertaken to prospect that portion of its property by means of cross-cuts. There is also some question of beginning another open working in the southern part of the concession.

Jeffrey mine, The Asbestos and Asbestic Company. During the year 1915 the wall of rock separating the main pit from the old Gosselin pit was cut down, thereby increasing the width of the open working to 1100 feet. The dumps of rocks, containing asbestos of good quality, which lay between the old Gosselin pit and the road were removed by means of a steam-shovel (Marion No. 2) to the new concentration mill at the rate of 650 tons per day.

Approach work is being done to allow of the rock, taken from the various benches of the mine by means of powerful steam shovels, to be loaded directly on the cars. This work consists in excavating trenches in the surface ground so as to have railways with a slight gradient for each bench on which the cars and locomotives can run.

In addition to these changes in mining methods, the company has made improvements in the construction of the cable-derricks.

A new kind of carriage has been adopted. It consists of a steel suspension carrying cable an inch and a half in diameter, so made as to counteract the twisting action of the cable itself. There is a driving cable $\frac{5}{8}$ of an inch in diameter as in the old pattern, but differing in the arrangement of the return pulleys at the opposite ends of the hoist drum. The block from which hangs the box is carried by three $\frac{5}{8}$-inch ropes instead of by two, as in the old pattern. In designing the new carriage, the steel beams have been so arranged as to take into account the action of the various forces coming into play.

The *Bell Asbestos Mines Co., Limited* is completely remodelling its mill. As before, it will comprise two independent units consisting of a jaw crusher, a steam dryer, an electro-magnet, two jumbos, a cyclone and two shaking tables from which the fibre is removed by suction. The motive power for the various machines in the mill is furnished by four induction motors with a total capacity of 1000 H.P.

A new Ingersoll-Sergeant air compressor, driven by an alternating current motor, was also put in during the past season.

The Bell mine is the only place where underground mining is carried on during the winter months.

At the *Black Lake Asbestos and Chrome Co., Limited*, mines, work was done only in the Union and Western pits last year. Prospecting with diamond drills was carried on with good results which will be taken into account when enlarging the workings. Borings to depths of from 120 to 150 feet with varying inclinations enabled an area having a commercial value to be located.

At the *Martin-Bennett Asbestos Mines Limited*, ore is got out from two pits. The largest is on the north side of the railway; the second is on the opposite side near the boundary of the Bell mine and measures 85 feet in depth from the new bench on which mining has been begun. The rock from that pit is conveyed to the surface in trucks running on an inclined plane at the head of which is a small bin. The trucks are loaded by means of a small cable-derrick.

At Ash Creek, in the State of Arizona, 40 miles north of Globe, mining has been continued on some asbestos deposits showing serpentine in contact with limestones. A company has even finished building a mill.[1]

Russia which produces most asbestos after Canada, produced 18,594 tons in 1914.[2]

In California the Trinity Asbestos Co. Limited, announces that a large reserve of rock-bearing, high-grade asbestos has been marked out[3] and a mill has been built 18 miles east of Carville, Cal.

COPPER

The great demand for copper ores in the United States in 1915, owing to the large quantity of that metal used for war materials, caused a rise in prices and increased production throughout North America. From 13.6 cents per pound, as quoted at the beginning of January, prices rose to 20.1 in December.

Although the Eustis mines had to suspend operations twice during the year, we note an increase of 21% in the production of copper ores in the Province of Quebec while the value of the same exceeds the value of what was mined in 1914 by 27%.

The production in 1915 amounted to 142,797 tons, sold as sulphur and copper ore, the price being $1,021,777. The principal shipments were from the Weedon mine, lot 22, range II, Weedon township, by the Weedon Mining Co.; from the Eustis mine, near Capelton by the Eustis Mining Co.; from Stratford prospect, lot 8, range VI, S.W., Stratford township, by Mr. P. E. Beaudouin.

The Eustis Company has continued its development work in 1915, the inclined shaft was 3950 feet deep and new levels have been driven at 100 feet apart, in the last 300 feet. As this work showed the existence of a quantity of ore having a commercial value, the company made the necessary arrangement for doubling the capacity of its mining machinery.

---

[1] The Engineering and Mining Journal, page 988 ,Vol. C.
[2] U. S. G. S. Asbestos, 1914—J. S. Diller.
[3] Mining and Scientific Press, 26th June, 1915.

An unfortunate delay was caused through the destruction by fire at the end of April of the water-power house producing the electricity needed for driving the various machines in the concentrator which latter was also completely burned down on the 26th August. To meet the needs of the moment, a crushing mill was at once put up. At the end of the year new concentration works, with an estimated capacity of 500 tons per day, were being installed in a brick building on the site of the former mill. The company also did some prospecting with diamond drills near the deposit now being mined; also a little, in the spring, at the Hepburn mine.

The Weedon mine worked without stopping throughout the year 1915. As at the Eustis mine, the producing capacity was doubled, it is now 400 tons per day. The shaft has been carried down to the seventh level and is 530 feet deep. At the bottom a new centrifugal pump made of acid-proof bronze and driven by a 60 h.p. induction motor, was installed on a concrete foundation. The aerial tramway has since recently been driven by a 25 h.p. induction motor. The ore is shipped without preliminary preparation to the Nichols Chemical Works at Capelton and to the United States.

Mr. P. E. Beaudoin (La mine de cuivre et d'or) continued to mine the Stratford prospect seven miles from St. Gerard, whence he made considerable shipments to the Grasselli Chemical Co., Ohio

Mr. Pierre Tétreault pumped out a portion of the Huntingdon mine in 1915 and did some work in connection with the timbering, among other places in a shaft 12 x 5 feet with two compartments, to a depth of 50 feet at a distance of 100 feet from an old inclined shaft. A vertical boiler and a motor were put in. Some tons of ore and some matte containing 21% of copper, the residue of the working of an old blast furnace, were shipped.

Mr. N. S. Parker did some work on the prospects known as the Clark mine, Sherbrooke, near Lennoxville, St. Francis mine, near Richmond, and Bolton mine, near Eastman.

The Ives mine, between Eastman and Bolton was pumped out and samples were taken from it during the summer for Nova Scotian capitalists. A carload of the ore was shipped to New York.

Three miles from Amos village, in the district of Abitibi, Mr. Joseph Tremblay discovered, in August, 1915, a deposit of copper

ore on lot No. 42, range II., Dalquier township. In December, Messrs. Campbell & Forbes undertook to prospect the lot under an option. A first carload of ore was shipped in the spring of 1916.

GOLD AND SILVER

Last year the Province of Quebec produced 1,058 ounces of gold and 72,809 ounces of silver, respectively worth $23,082 and $36,182. Such production came from the mines of copper-bearing iron pyrites in the Eastern Townships and from the zinc deposits in Notre Dame des Anges, county of Portneuf. It represents an increase over 1914 of 9% for gold and 13% for silver.

For the first time we record gold and silver values from the zinc deposits of the county of Portneuf in the table of mineral production. In the summary report for the year 1914 of the Mines Branch of the Department of Mines, at Ottawa, on page 123, the result is stated of the assay of an ore of zinc, lead and copper, sent by Mr. Stanislas J. Pointon, of the Laurentide Mining Co., Notre Dame des Anges. That assay shows that the sample sent contained 1.74 ounce of silver to the ton. As the prospecting of some of the deposits gives satisfactory results, we may anticipate an increase in silver production with the development of the mines in Notre Dame des Anges.

No production from the alluvial deposits of the district of Beauce has been reported. The company Champs d'Or Rigaud Vaudreuil did no work.

The Mountain Creek Gold Fields Limited, which owns mining rights in the township of Chesham, county of Frontenac, did some prospecting for a short time last summer.

Mr. A. Renault, of Ville Marie, reported the work he did in the township of Desserat, county of Temiscaming, in block B, work consisting in trenching, prospecting pits, and a tunnel; the latter is about 50 feet long; on a vein from 3 to 4 feet wide containing pyrite and galena, a pit some 15 feet deep was sunk. The best assay showed $22 worth of gold and 48 ounces of silver to the ton. There are also 5 or 6 other pits about 10 feet deep, in which pyrite, galena and fluorine are found.

On blocks C and D of the same township pits from 7 to 8 feet deep were excavated on small quartz veins containing pyrite. The assay showed from $3 to $4 to the ton.

ZINC AND LEAD

The value of the production of zinc and lead for the year 1915 was $36,000. It came entirely from the development of the deposits in Notre Dame des Anges, county of Portneuf.

Owing to the considerable demand for zinc ores and the great interest to which the discovery of mineralized zones in that region gave rise, the Bureau of Mines directed Dr. J. A. Bancroft to report on the nature of the deposits and to obtain information regarding the general geology of the neighbourhood. After two months field-work during the summer of 1915, in the townships of Chavigny and Montauban and in a portion of the seigniory of Grondines, he gives the results of his investigation at the end of this volume.

The Tétreault mine on lot No. 40, range I, Montauban township has been worked since mid-December, 1915, by the Weedon Mining Company. Lately this company transferred all its interests in the zinc mines of Notre Dame des Anges to the Zinc Company, Ltd.

During the year 1915, development work was actively pushed. The 14 x 7 feet inclined shaft with a dip of 58° has reached a depth of 175 feet. At 75 feet is a drift at least 200 feet long running true south. The ore is taken out by mine cars, hoisted by a small engine at the foot of the head-frame. Two Cameron pumps, with a capacity of 60 gallons per minute, suffice to pump out the water from the bottom of the mine. When the ore leaves the shaft, it is automatically dumped into trucks and conveyed to a bin with a capacity of 720 feet. Thence it is conveyed in small trucks to the head of the concentration mill by an inclined plane 800 feet long.

Mr. Tétreault's old mill has been enlarged and re-modelled. The ore passes through a Blake crusher 8 x 16 inches, then is lifted to a bin whence, by a shaking discharge pipe, it is taken to two cylindrical crushers whose rolls measure 14 inches in surface by 30 inches in diameter. The ore is elevated and passes through a trommel; the fine and coarse, after being again crushed in a third set of rolls are carried to a shaking screen and four Wilfley tables.

The blende is afterwards sent to a magnetic separator to remove the pyrrhotite. The blende, pulverized in a Hardinge mill, passes into an oil-flotation separator. Outside the building are two bins, one for the galena concentrates and the other for the zinc concentrates. Motive power is supplied by a steam-boiler, with two steam engines of 40 and 100 H.P. respectively driving the machines in the mill.

The new company intends to make the mill four times larger during the current year. A roaster near the C.N.R. track is almost completed. The ore will be first roasted before being sent to the electrolytic refinery at Welland, Ontario, owned by the company, which works by a new process invented and developed by Mr. Watts, a metallurgist, a graduate of Queen's University, Kingston, Ont., while engaged in research work in the laboratory of that institution.

The Montauban Mining Syndicate owns mining rights on lot 45, range I of Montauban Township. The prospecting work consists of two shafts carried down to a depth of 30 and 51 feet respectively. At the latter is a mining plant consisting of a head frame, a small hoist, an air compressor, etc. At the bottom of the shaft, a cross-cut, 45 feet long, has been carried in an easterly direction. The work was done under Mr. Thibault's direction.[1]

Very interesting samples of galena and blende were sent to the Bureau of Mines from the unsurveyed portion of the Gaspé peninsula. The New Richmond Prospecting & Mining Co., Limited, has just been formed to develop claims about 40 miles north of the Baie des Chaleurs on Berry Mountain creek, a branch of the Great Cascapedia river.

Until the month of January of this year, the work consisted in clearing off the timber, excavating trenches and sinking a shaft 40 feet deep. The company intends to actively push its development work. A mining plant including drills, an air-compressor, a 120 h.p. boiler, and a hoist were shipped there during the past winter.

The Wright mine, now owned by the Hollinger Syndicate, and which is situated eight miles north of Ville-Marie in Duhamel township, was pumped out during the month of October, 1915. Ten men worked two months and a half, at making a thorough sampling of

[1] See Dr. J. A. Bancroft's Report further on in this volume.

the mine. The work on the mine had been suspended since 1903, although, in 1906, some attempts were made to resume work but were abandoned. The developments to date consist in a vertical shaft, 350 feet deep and drifts at levels of 50, 100, 250 and 350 feet, all running in a southerly direction for distances of from 50 to 100 feet. In some places are stopes from 30 to 40 feet high. At the pit-mouth is a concentration mill comprising three crushers, four Wilfley tables, ten jigs, three boilers and motors and a dynamo.

In the report outlining operations 1901, Mr. Obalski wrote:

"The ore is found in a mass of calcite, the mode of formation whereof I have hitherto been unable to determine but which looks like a sort of chimney. The galena is disseminated in proportions varying from 20 to 25 per cent in the rich parts, and is about 5 per cent in the poorer parts. It is estimated that the mine yields one ton of concentrates for every nine tons of ore taken out; the concentrated ore contains from 70 to 77 per cent of lead, and from 15 to 17 ounces of silver to the ton. The galena seems more abundant at the lower levels."

In the reports on Mining Operations in the Province of Quebec for the years 1901 and 1902, we see that the following shipments of ore were made from the Wright mine:

In 1901.—227 tons of concentrates with from 70 to 77 of galena.

In 1902.—300 tons of concentrates with from 70 to 77 of galena.

BOUNTY ON ZINC

The price of zinc has fluctuated to an enormous extent since the beginning of the war—from ten cents a pound in the spring or 1914, it rose to 40 cents shortly after the outbreak of hostilities; in April, 1916, orders were given at the rate of 16 and 17 cents. To encourage the mining and refining of Canadian ores, the Federal Government, by a resolution assented to in May, 1916, granted a bounty of two cents per pound of zinc, payable only if the war ended before the 31st July, 1917, and on condition that the market price be under eight cents.

IRON

No iron ore was taken out from the mines of the Province of Quebec during the year 1915. The Canada Iron Foundries Co., Ltd. owning the Radnor and Drummondville blast furnaces, has not yet resumed operations on its mines. In 1915, as in 1914, titaniferous ores were not shipped but it is reported that the Titanium Alloy Manufacturing Company has given an order for titanic iron ore to the Manitou Iron Mining Company, to be shipped from the Ivry mine to Niagara Falls.

The Bureau of Mines published in 1915, a report by Mr. P. E. Dulieux, mining engineer, on the Iron Ores of the Province of Quebec—Their deposits and utilization. This work published in French, is the result of an investigation of the deposits of iron ore in the Province of Quebec. The description of the deposits is followed by notes on the concentration and utilization of ilmenites and titanomagnetites.*

MINERAL PAINTS

The value of the production of iron oxide in 1915 was $42,285, being a marked increase over the previous year; in fact it is the largest production recorded by the Province to date.

These ores came chiefly from the county of Champlain, where three companies are working surfaces deposits.

The Canada Paint Company owns the rights on an area of land equal to one thousand acres, ten miles east of Three Rivers. The deposit, which contains three varieties of ochre, has a width of half a mile. It consists of a layer of very pure ore yielding, on analysis, from 93% to 98% or iron oxide. In some places it is twelve feet thick and rests on a clay bed.

The ore is loaded on small cars and conveyed to the mill by a small railway. A portion goes to a storehouse, with a capacity of 1,000 tons, to be calcined during the winter season. At the mill the ore is first dried by placing it in the upper part of two ovens, after which it is calcined in the lower sections of the same. The degree of

*The results of the field investigations of Mr. Dulieux on the iron ores of Quebec, have been published in English in the annual reports on the Mining Operations for the years 1911 and 1912.

heat to which it is subjected depends upon the quality of the raw material and the color sought to be obtained. It varies between 1,600 and 2,200 degrees Fahrenheit. Before being taken out of the ovens, the iron oxide is carefully assayed and compared with the standard colors to make sure that the proper shade has been obtained. The product after being taken out of the oven, is cooled and sent to a pulverizer (Sturtevant Rock Emery Mill), on leaving which, it has to stand a sieve test of 350 mesh.

CHROME

Mining the deposits of chromite of the Province of Quebec, especially in Coleraine township, was carried on with an activity hitherto unknown. A total quantity of 14,397 tons was taken out during the year 1915. The table of the production of chrome iron in the Province of Quebec, published on page 32 of the annual report for 1914, shows that the largest shipment of chromite previously made was in the year 1906, and amounted to 9,035 tons.

Before the war the United States which obtained this ore chiefly from Rhodesia, New Caledonia, Turkey and Greece, were unable, after the mobilization of the principal vessels of the mercantile navies of the various belligerent countries, to import in such large quantities from these sources. Moreover, the metallurgical works were overloaded with orders, and were working without cessation; and, although we do not know the quantity of that substance consumed in the United States in 1915, it may be presumed that it greatly exceeds the 80,736 tons of the year 1914. These figures show an increase of nearly 24% over the previous year. Now, in 1914, the United States imported 99% of the ore they needed. It is therefore easy to form an idea of the state of the market in the spring of 1915.

The demand, added to the difficulty of procuring this material required in metallurgical works, induced the brokers dealing in ores, to purchase in the Province of Quebec. This province is the only one in Canada which possesses deposits of that substance, apart from the Tulameen district of British Columbia where the existence of chrome iron has been reported. In the United States, it is found in California, Wyoming, Maryland, Pennsylvania and North Carolina. Some of the old workings were reopened in June.

The first shipments were of ore from the dumps around the old workings. Much of the ore contained not more than 20% of sesquioxide of chrome. At the end of the year, purchasers refused all shipments containing less than 25%.

In some instances, it is found advantageous to use ore containing less than 25% $Cr._2 O_3$. Such low-grade shipments are mixed with very rich ores. The demand is, as a rule, for ore yielding over 38% of $Cr._2 O_3$ on analysis. Purchasers also take the proportion of silica in the ores into account.

During the fall of 1915, prices gradually rose. The table below shows the average prices per long ton, at the shipping station:

Ore with a percentage of from 25 to 30 % $Cr._2 O_3$	$14.00
" " " " 30 " 35 "	16.00
" " " " 35 " 40 "	18.00
" " " " 40 " 45 "	20.00
" " " " 45 " 50 "	25.00

Before the war, only chrome iron ore containing a percentage of approximately 50 of sesquioxyde of chrome was sold on the American market. In the year 1914 prices varied between $14.50 and $15.50 per ton. All ore containing more than 50% sold for from 50 to 60 cents per unit.

The chrome ores were mined from already known deposits on the properties of the Black Lake Asbestos and Chrome Co., Ltd., blocks A and B which are leased to Mr. P. E. Beaudoin of Thetford Mines; from the old Montreal pit on lot 26, range II, Coleraine township, now worked by the Dominion Mines and Quarries Co., Limited, of Toronto; from the Ward-Ross Mine, lot 26, range B., Coleraine township, worked by Mr. Jos. M. Johnston, of Black Lake. Mr. David Wilson, of Sherbrooke, shipped some loads from lots 5 and 6, ranges B and 9 and 10, range IV. Coleraine township; Mr. W. J. Woolsey mined the deposits on the block belonging to the Asbestos Corporation of Canada, Limited, lying east of block A., and also did some work on Block C, range I, southeast, Garthby township, belonging to Mr. R. J. Stewart Patterson.

Other small deposits were also mined, among others those situated a short distance north of the open workings of the Robertson

Asbestos Company on lot 17, range V., Thetford township, and on Mrs. Noel's property, lot 23, range B, Coleraine township. The Martin-Bennett Asbestos Mining Co., Limited, has, since the month of November of last year, kept a gang of some twenty men at work on a rather large deposit on lots 28, range I and 26, range II, Ireland township.

Outside the immediate vicinity of the Black Lake area range X of Orford township is the only place from which chromite was taken during the past year. The Fletcher Pulp & Lumber Co., Limited, did some work there during the last two months of 1915.

In the annual report on Mining Operations in the Province of Quebec during the year 1914, will be found a table of the yearly production of chrome iron from 1894 to 1909; a list of the known deposits, and very interesting details regarding the chromite deposits of Coleraine township.

As a rule, the deposits that have been mined are not very large. They are of a very irregular lenticular shape and their dimensions vary. Some of the lenses have N. E.-S. W. direction with a dip to the north. They contain from a fraction to some hundred tons of ore which is either compact or in the shape of disseminated grains.

Most of the owners of mining rights do not work the mines themselves but lease them to others; the lessees in their turn have the mining done by contract. Owing to the nature of the deposits and the small capital at the miners' disposal, mining methods are necessarily primitive. As a rule, the workings are open and shallow. Sometimes, when the topography of the ground admits, drifting is resorted to. Drilling is done by hand to mine with explosives. The cobbing is done in the pit or on the surface. Ore and barren rock are hauled to the surface on sleds up an inclined plane, or are hoisted by a small derrick. When the deposits are large enough, the mining is done with a mechanical drill.

Most of the chrome iron from the various deposits in Coleraine township was shipped to the State of Pennsylvania where it is used in making refractory lining for blast furnaces and the hearths of metallurgical furnaces. Chromite is also used for making ferrochrome—a mill for that purpose is in operation at Niagara Falls, United States; also in the manufacture of chemical compounds of certain dye-colours. Of late years, an alloy has been made of it

with nickel and vanadium to harden the heads of shells and the plates for ironclad ships. Such alloys are also used in making some parts of automobiles and other metal pieces requiring certain special properties.

Although, at the beginning of the year 1916, the representatives of American mills were more exacting in their purchases regarding the quality of the ore, the market remained very steady and we are told that prices are getting better and better.

With a view to securing a constant supply of ore, and to evade the hazards of the maritime transport problem, the Mutual Chemical Company of America, through its subsidiary branch in this country, the Mutual Chemical Company of Canada, is building two concentration mills in Coleraine township. The old works, known as the "Red Mill," near the Quebec Central Railway, between Coleraine and Black Lake stations, will be used for the first one; its daily output will be 30 tons of concentrates. The second is being built at Little Lake St. Francis and will have a smaller output, from 100 to 125 tons per week. Concentration will be effected by the wet process and it is expected that it will be possible to treat ores containing only 10% of sesquioxyde of chrome by means of stamp mills and Wilfley tables.

MOLYBDENITE

Not one of the known deposits of molybdenite in the Province of Quebec was mined for commercial purposes during the year 1915.

Some development work was done. Messrs. Forbes & Campbell, with eight men worked on the property of the Height of Land Company in the township of Preissac, Abitibi. The St. Maurice Syndicate, owning the mining rights in the Lake Keewagama peninsula, Abitibi, also had some work done. Last December, the Mines Branch of the Federal Department of Mines sent a party to get 5,000 pounds of ore to be treated in their testing plant at Ottawa.

A company, in which American, British and Canadian capitalists are interested, was recently incorporated under the name of "The St. Maurice Mines Co., Limited." The directors intend to undertake the development of the Lake Keewagama deposits during the summer of 1916.

Molybdenum is now in great demand as a substitute for tungsten in the manufacture of certain special steels. This metal is chiefly used in making molybdenum steel—which is very tough and very hard—for the manufacture of tool steels; barrels of rifles and guns; it is also used in making some chemical compounds, etc.

Before the war, molybdenite sold for $500 per ton of concentrates at 90%; at present, owing to the limited quantity got out and the state of the market, it is quoted in London as high as $2,300.

The molybdenum ore offered for sale until a few months ago, was the result of concentration by hand-picking. That process is costly and the yield is liable to vary. After lengthy investigation, Mr. Henry B. Wood, of Denver, Colorado,[1] devised in 1912, an apparatus capable of concentrating that ore mechanically. The important alterations since made in that machine are said to allow of crude ore containing ½% of MoS_2 being commercially treated.

The machine consists of a hopper of a special type and two prismatic basins, the whole supported by a metal structure. The ore, when dried, is taken to the hopper and is uniformly distributed over the surface of the water in the flotation basin; well directed jets of water direct the ore, which is balanced on the tension surface of the water, to a belt which conveys it to the second or concentrates basin.

The few moments during which the particles of ore are in contact with the water allow of the gangue being sufficiently moistened to drop to the bottom of the basin whence it is removed. After a shorter passage over on the surface of the second basin, the molybdenite is collected. The gangue which has not been separated in the first basin has had ample time to become moistened and falls to the bottom of the second basin. An apparatus of this kind can treat ore with ½% of MoS_2 at the rate of from 10 to 20 tons per 24 hours with a recovery of from 80 to 90%. One of these machines has just been installed in the testing laboratory of the Mines Branch of the Department of Mines at Ottawa.

In Norway, two mills for concentrating molybdenite ore give satisfactory results from the use of the oil flotation method (Elmore process).

---

[1]The Concentration of Canadian Molybdenite Ores, Bulletin 47, C. M. I.

GRAPHITE

The New Quebec Graphite Co., Limited, of Buckingham, did no work during the year 1916, owing to extensive alterations in the machinery of its concentration mill. The old crusher and the rolls which did not give satisfaction, were replaced by a new jaw-crusher and a ball mill. When the installation of this machinery was finished, the company made a ten days' trial.

The Canadian Graphite Co., Limited, whose mine is in Wentworth township, did only development work. In an article which appeared in Bulletin No. 34 of the Canadian Mining Institute, Mr. H. P. H. Brummel, stated that, through certain improvements in the method of concentration, the loss in the tailings had been lowered from 4.5% to 1.5% for ore containing 9% of graphite.

FELDSPAR

As may be seen by the table on page 9, the production of feldspar was very small: 32 tons. That quantity came from a single mine in the township of Portland East, in the Gatineau-Lievre district, and it was used in making artificial teeth. Since the month of December last, the Eureka Flint and Spar Co., of Trenton, N.J., has begun to work at Ste. Rose de Lima. Feldspar is chiefly used for glazing bricks, tiles, pottery and earthenware; as a bond in making emery or corundum wheels; in making certain kinds of soap and artificial teeth.

Much work has been done to obtain salts of potash from orthoclase feldspar. These experiments have not so far succeeded in putting the exploitation of that source of potassium on an industrial basis although improvements in already known methods have produced results which must be taken into account.

MICA

The inactivity in mica mining in 1914 continued throughout the greater part of last year. There was a demand for that mineral only in the latter months, purchases being chiefly by manufacturers interested in making war munitions.

The value of the mica production in 1915 was $55,897. In 1914 it was $67,278, and in 1913 $117,038. The table below gives the average prices for the various sizes of sheet mica during the year 1915.

1 x 1 inch	5c. per lb.
1 x 2 inch	10c. "
1 x 3 inch	15c. "
2 x 3 inch	35c. "
2 x 4 inch	55c. "
3 x 5 inch	75c. "
4 x 6 inch	$1.00 "

In the month of December of last year, purchasers of mica offered better prices and terms than at the end of 1914.

The best varieties of mica which split into very thin sheets are now in demand : they sell for 28 cents per pound for sheets 1 x 1 inch and 32 cents for sheets 1 x 2 inches.

The chief places from whence mica was shipped during 1915 are the townships of Wright, East Portland, Templeton, Gore of Templeton, Wentworth, Harrington, Villeneuve, Derry West, Lochaber.

No work was done in 1915 at Mr. Richard's mine, Petit Pré.

Sheet mica of small dimensions is used as insulating material in electrical apparatus. The large sheets are used in the manufacture of fancy articles; the waste, finely pulverized, in making lubricants, also for certain paints and decorative paper, to produce a gloss or to reflect light; boards are made of it, mixed with cement; it is also used in certain rubber products. Boilers and steam pipes are sometimes covered with it. Some shell manufacturers use powdered muscovite for annealing the points of projectiles.

KAOLIN

Among the mining operations which are assuming larger proportions in the Province of Quebec, may be mentioned the kaolin mines of St. Rémi d'Amherst situate in the mining concession comprising lots 2, 3, 4, 5, 6, 7 and 8, range VI south of Amherst

township, and owned by the Canadian China Clay Co., Limited. For the year 1915 the value of the production was $13,000, while in 1913 and 1914 it was $4,354 and $9,000 respectively.

So far the work has been done on lot 5, but during the past year another deposit of kaolin was found. A pegmatite was also discovered whose chemical composition approached that of the well known porcelain stones of Cornwall, Great Britain.

Below are comparative analyses of the Cornwall stone and of the china stone of St. Rémi d'Amherst:

	No. 1 Cornwall Stone	No. 2 Cornwall Stone	No. 3 Cornwall Stone	No. 4 Canada China Stone
Silica	73.39	69.50	71.66	72.96
Alumina	16.50	17.85	18.79	17.30
Potash & a little soda.	7.66	7.98	6.60	6.41
Fluorite	0.74	0.71	0.14	0.00
Lime	.50	2.66	1.70	1.50
Magnesia	.31	0.12	0.35	0.65
Iron, traces	....	....	....	0.10
Water and loss	1.25	1.30	0.91	1.10
	100.35%	100.12%	100.15%	100.02%

The kaolin of St. Remi d'Amherst is advantageously used as a filler in the manufacture of certain kinds of paper. This raw material finds a very good market in that industry.

Mr. John S. Bates,[1] superintendent of the laboratory of forest products of Canada, after many tests on kaolin, submitted by the Canadian China Clay Co., Limited, containing:—

Moisture	0.89%	
Water in combination	13.25%	
Arenaceous matter	0.45	(Test by flotation)

[1] Private Report to the Canadian China Clay Co. Limited.

reported the following results obtained from three experiments with blotting paper.

	Blotting-paper No. 1	Blotting-paper No. 2	Blotting-paper No. 3
Weight per ream (500 sheets) 19 x 24 in.....	45 lbs.	47 lbs.	56.4 lbs.
Mineral residues.....	9.72%	8.05%	17.9%
Incorporated clay.....	76.8%	28.1%	62.5%
	(Average: 55%)		

In studying these results, the three varying factors in the tests are, the length of the fibres, the duration of the mixing, and the meshes of the screen. In the three experiments mentioned above, the duration of the mixing was a maximum for the first and a minimum for the last. The meshes of the metal screen used for the first experiment were much closer than those of the screen used for the two other experiments. Taking the two other factors into account, the percentage of clay incorporated in the blotting-paper is in direct ratio to the length of the fibres.

Besides its use as a glossing agent in paper-making, kaolin is used in the manufacture of china and earthenware. Before being put on the market, the kaolin must undergo a washing during which the fine clayey parts are separated from the silicious sand. This by-product now easily finds purchasers; recent experiments at the works of the Canada Steel Foundries have demonstrated the superiority of this sand over that from the United States in making moulds for casting pieces of superior quality steel. This is explained by the presence of a slight proportion of very plastic and very refractory clay. The company owning the St. Rémi deposits is making the necessary improvements and alterations in its washing plant for the purpose of preparing that by-product for the market.

It is probable that such silicious sand may be successfully used for making glass.

Mr. J. Keele, the ceramist of the Federal Department of Mines, has made experiments with raw kaolin with a view to the manufacture of refractory bricks. By mixing the burned product, in certain proportions, with the raw material and ordinary clay, very interesting results have been obtained. As most of the refractory

bricks now used in Canada are imported, the commercial possibility of such articles should be advantageously solved.

Dr. A. Bigot, of Paris, after making experiments with St. Rémi kaolin, has no doubt that such clay can be utilized as a refractory product. He also made experiments by mixing it either with corundum, chromite or graphite, and concludes that this substance very readily lends itself to the manufacture of crucibles, chrome bricks, etc.*

The considerable market opened for this substance and the success of the experiments in connection with the use of kaolin in various industries, led the Canadian China Clay Co., Limited, to apply for authorization to increase its capital to $1,500,000. Since then the company has started constructing a railway from Huberdeau junction on the Canadian Northern Railway to the mine and the directors have decided to, at once, enlarge their washing plant, so as to have pure kaolin and by-products which will meet purchasers' requirements.

MAGNESITE

In 1915, the Province of Quebec produced 285 tons of magnesite in the raw state and calcined magnesite, representing a value of $137,353. Such production is the result of the work of the four following companies. The North American Magnesite Co., Canadian Magnesite Co., Scottish Canadian Magnesite Co., and Messrs. Fitzsimons and Boshart. There is a fifth company, the Dominion Magnesite Co., but it has not worked yet. All the properties of those companies are situated in the township of Grenville and Augmentation of Grenville. Among the various branches of the mining industry of the Province of Quebec, that of magnesite made the most progress during the year just ended. Its development is entirely due to the European war. In fact, the American market, 96% of whose consumption came from Europe, was unable to get any from Austria-Hungary which country alone furnished 93% of its imports. The United States have fairly important deposits in California, but difficulty of access and the remoteness of the deposits from the large metallurgical centres of the East, render their mining difficult owing to the high price that has to be charged.

It is as a substitute for the Austrian magnesite that use must be found for that of this Province in order to retain the importance

*Private report to Hon. Dr. P. Pelletier, London.

it has acquired in the past months. The ore imported from Austria-Hungary contains from 6% to 8% of iron and is chiefly used in the manufacture of refractory materials required in the metallurgical industry. The percentage of iron is an advantage; when the ore is subjected to a certain degree of heat the iron acts as a bond. Previous to the war, raw European magnesite sold at from $7 to $8 in New York.[1]

Owing to its binding qualities and its cheapness, the imported Austro-Hungarian product has been preferred by American metallurgists, although they are trying to obtain their supplies from deposits on the American continent to avoid the risks and uncertainties of ocean transport.

After practical experiments made by metallurgical companies using Grenville magnesite, it is thought that, even under normal conditions, that product can compete with the Austro-Hungarian one.

After a series of experiments with Grenville magnesite, Mr. F. R. McKune, of the Steel Company of Canada, has succeeded, by adding a certain proportion of blast furnace slag, in making linings for open hearth steel furnaces which have given very satisfactory results.

We give below the analysis of the materials used:

Grenville magnesite, crude:—

Silica.....4.93%
Oxide of iron, aluminium.....0.63%
Carbonate of calcium.....18.37%equivalent to 10.32%, Ca. O.
Carbonate of magnesium.....74.09%equivalent to 35.28% Mg. O.
Sulphur.....0.020%

Slag:—

Silica.....9.81%
Aluminium.....1.78%
Oxide of iron.....17.29% equivalent to 12.61% Fe.
Lime.....51.97%
Magnesia.....6.74%
Phosphoric acid (P_2O_5).....2.70% equivalent to 1.18% P.
Sulphur.....0.247%
Oxide of manganese.....5.67% equivalent to 4.39% Mn.

[1] Mineral Resources of the United States—Year 1914—Part II.

The calcined magnesite is mixed with 20% of pulverized slag. The proportion of lime in the latter offers no drawbacks in the case of open hearth furnaces.

The plant of the North American Magnesite Co. comprises a quarry and a calcining kiln. From the bottom of the open working the stone is conveyed to the mouth of the kiln by a cable-derrick. The kiln has a capacity of 170 bags of 165 lbs. of completely calcined magnesite per 24 hours. The quarry is situated ten miles from Calumet station on the Canadian Pacific Railway.

Uses.—Magnesite, in the raw form is used for making carbonic acid and magnesia. The product of the semi-calcination, mixed with magnesium chloride, is used for making magnesia cements (Sorel cement) with which are made the monolithic floors, recommended for their sanitary properties. The paper industry also requires a certain quantity for dissolving the resin contained in pulp made from coniferous trees. The greater portion is used in metallurgical works as refractory material. It is used in making certain paints on account of its drying properties. Chemical industry has also found many other uses for it.

Through the initiative of the Shawinigan Water & Power Co., after considerable laboratory work, its subsidiary company, the Shawinigan Electro-Metals Co., Limited, has begun to produce metallic magnesium for the trade.

Previous to the war, nearly all the metallic magnesium used in America was imported from Germany.

The chief uses of magnesium, as described by Dr. William M. Grosvenor in a lecture before the American Electro-Chemical Society[1] are the following: as reducing agents in refining certain metals; it forms valuable alloys when mixed with aluminium and other metals; it is used for military purposes and in photography owing to its illuminative power.

MINERAL WATER

The reports sent us by producers show that the Province of Quebec sold mineral water for a value of $33,084, representing 358,275 gallons. The marked increase over the previous year is due to a company which has sent a report for the first time.

[1] See Metallurgical and Chemical Engineering.

We wish to say that the quantity above mentioned represents only what was put on the market as mineral water, and that our statistics do not cover the quantity of water furnished by the many artesian wells in the Montreal region. Some industries, which consume a considerable volume of water daily, prefer to get it from artesian wells rather than to buy it from the Montreal water-works system.

In memorandum No. 72 by Mr. C. L. Cummings, of the Geological Survey Department of Canada, on the artesian wells of Montreal, we read that, in that city, 179 wells furnished, in April 1913, 7,000,000 gallons of water per day. That water is mostly used as a refrigerant, especially for condensing steam in summer. An appreciab'e quantity is used in boilers owing to its cheapness, although the salts it contains often render it injurious.

The results of Mr. Cummings' inquiry are most interesting. The report mentions that the existence of an underground sheet of water is but slightly probable; that there are greater chances of striking a spring of water at a depth varying between 400 and 700 feet; that the waters may be classed according to the salts they contain into one of the following divisions: Carbonate of sodium, sulphate of sodium, chloride of sodium, carbonate of calcium, chloride of calcium or magnesium and sulphate of calcium or magnesium.

This valuable report gives a detailed description of the wells and analyses of the waters.

STRUCTURAL MATERIALS

The table of mineral production shows a decrease of 25% in structural materials. The operations most affected are those in connection with granite, sand, lime and bricks. The general halt in the growth of the cities and towns of the province has also affected the production of cement. By the figures given in the March number for this year of the *Labour Gazette*, we see that activity in building operations decreased by a good half in 1915. We find, however, that the effects of the war and of the financial depression have not been so disastrous with us as in some other provinces. The city of Sherbrooke and the town of Chicoutimi are the only ones whose growth has not decreased.

If one may judge by the figures in the table on page 9, limestone shows a slight increase. More than 60% of the limestone was used in the shape of broken stone, mostly in making macadamized roads.

The quarries of the Delorimier group, formerly the most important around Montreal, are at an advanced period of decline. The proximity of dwelling houses renders their operation dangerous. On the other hand we find new groups assuming more and more importance, among others that in Masson Street, west of Pie IX boulevard in Rosemont; a second group extending along the north side of the electric railway running to Bout de l'Isle from Tetreaultville to Longue Pointe. On Ile Jesus, there are important quarries at Cap St. Martin, and St. François de Sales, while, a large company which is at present erecting a crushing mill of great capacity, will open a new quarry this summer at St. François de Sales, east of St. Vincent de Paul.

Some tons of limestone of the carboniferous age, were sent to a pulp mill from Chandler.

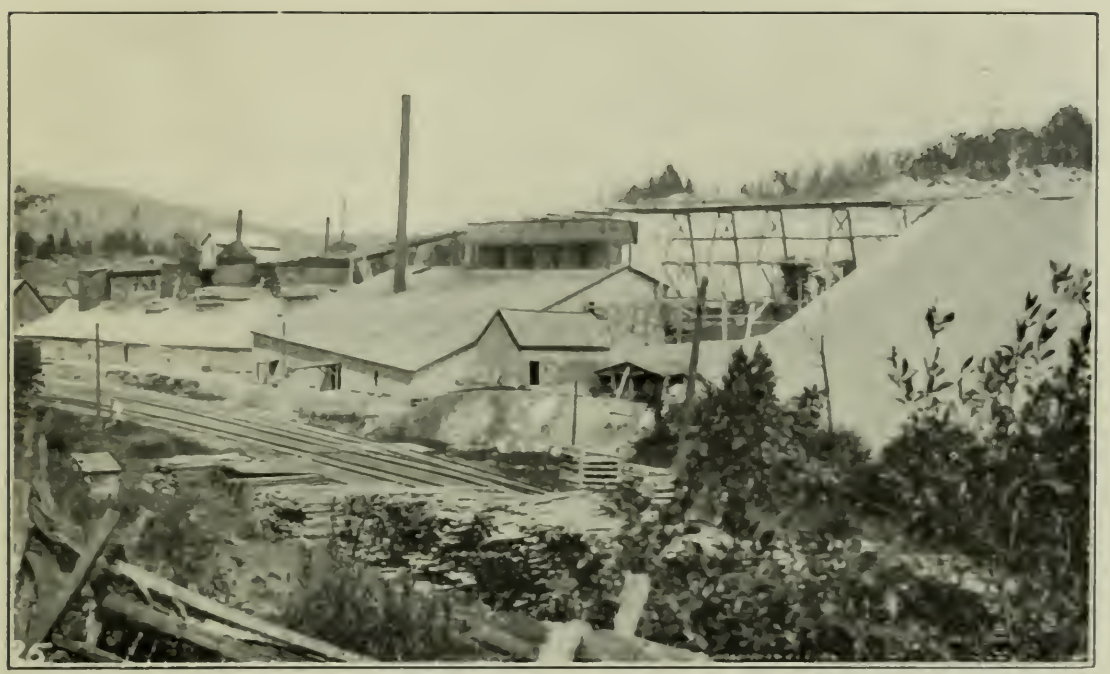
During the summer of 1915, work was resumed in the sandstone quarries of Ile Perrot, of Melocheville and St. Simon, county of Two Mountains. Some thousand tons of sand from the Potsdam sandstone of Melocheville, county of Beauharnois, were sold to a Montreal glass-works. The sandstone from St. Simon was used for paving certain streets of the city of Ottawa.

Work was resumed in May on the New Rockland state quarry, which was not worked during the winter of 1914-1915, and a new cut was begun in the latter months of the year.

The Province of Quebec possesses quarries capable of supplying structural materials which, both as regards quality and dimensions of the blocks compare to advantage with those of the other provinces or other countries.

From some of the limestone quarries of St. François de Sales and St. Marc des Carrières, blocks of stone can be obtained of dimensions suitable for all structural needs. The Stanstead Granite Co., whose mechanical dressing works is the largest in the province, has just added to its machinery a powerful lathe which can work on granite columns 25 feet long. At Rivière à Pierre, St. Samuel de

PLATE III.



Dominion Lime Co.—Kilns at Lime Ridge, P.Q.

PLATE IV.

La Compagnie de Granit de Mégantic.—Plant at St. Samuel, Whitton township.

Whitton, Stanstead, in the county of Argenteuil and in the township of Campbell, granites are quarried which, for uniformity of grain, freshness of color and solidity of blocks, can compare to advantage, even on foreign markets, with the granites of other countries.

Marbles for interior ornamentation can be obtained from Missisquoi and South Stukely. There marbles, whose delicate tints blend pleasingly, are admirably suitable for ornamental stones.

NATURAL COMBUSTIBLE GAS

In the county of St. Hyacinthe, deep borings have been carried on in search of workable gas-bearing pools.

The Canadian Natural Gas Co., whose driller is Mr. Edmond Côté, now has four wells, two of which on lot 164, North range of St. Amable, 1,000 feet apart, are sunk to depths of 1,880 and 2,900 feet respectively. A third was bored to a depth of 3,455 feet in 1915. about two miles to the east of the two others, a slight distance from the Yamaska river.

A fourth well was begun on the 9th October in the Parish of St. Jude, three miles north of St. Barnabé, and a depth of 2,450 feet had been reached at the end of the year. They expected to go beyond 3,000 feet.

The operators say they are satisfied with the results obtained, In all the wells so far bored, pockets of gas under high pressure—all over 300 lbs. to the square inch—have been reached according to Mr. Côté's reports. No systematic gauging of the flow of the various wells seems to have been done, and yet this would be an important point to determine for the high rock pressure recorded does not necessarily indicate that the flow will be steady and permanent.

A fifth well, begun in 1914 by the National Natural Gas Co. in the north part of lot 1319, St. André range, was stopped at a depth of 2,050 feet. The details of this well were given in our report on mining operations during the year 1914. Nevertheless an error had crept into that report and on the sketch accompanying it respecting this location of the lot, which we wish to rectify. In the report for 1914 this location is given as being on the north part of lot

1,354 of St. André range, while the description should read: "northern end of lot 1,319 of that range."

The borings done in 1915 brought to light the fact that the shales of the Lorraine group are thicker than had been supposed. The well 3,455 feet deep near the Yamaska river did not go through them and it would seem that, nowhere in the district, have the Trenton limestones yet been reached which must be penetrated into before any conclusive test can be made as to the possibilities of the region in connection with natural gas.

The indications so far ascertained are, nevertheless, encouraging and one may believe and hope that the operators' perseverance will result in discoveries which will compensate for the extensive explorations made during the past eighteen months.

In the report on mining operations in the Province of Quebec, during the year 1914, will be found a fairly detailed report on the work done in the region south of the St. Lawrence in prospecting for natural gas and oil as well as the logs of the wells bored.

LIST OF THE

Principal Operators and Owners of Mines and Quarries

IN THE PROVINCE OF QUEBEC

ASBESTOS

The Asbestos & Asbestic Co., Limited,
James R. Pearson, Mgr., Asbestos, P. Q.

Asbestos Corporation of Canada Limited,
J. M. Callum, Secretary, 263 St. James Street, Montreal.

The B. & A. Asbestos Co.,
J. A. E. Audet, Manager, Robertsonville, P. Q.

The Beaver Asbestos Co., Limited,
c/o John Dugal, Secretary, Tecumseh, Ont.

Bell Asbestos Mines,
Hon. Geo. R. Smith, Vice-Pres. and Mgr., Thetford Mines, P. Q.

Berlin Asbestos Co.,
Geo. Rumpel, Pres., Berlin, Ont.,

Black Lake Asbestos & Chrome Co., Limited,
J. E. Murphy, Mgr., Black Lake, P. Q.

Eastern Townships Asbestos Co.,
P. Anger, Mgr., Beauceville, P. Q.

The Frontenac Asbestos Mining Co.,
F. W. Ross, Mgr., 92 St. Peter Street, Quebec.

Jacob Asbestos Mining Co., of Thetford, Limited,
Paul Hammerick, Mgr., Thetford Mines, P. Q.

Johnson's Co.,
A. S. Johnson, Mgr., Thetford Mines, P. Q.

Ling Asbestos Co., Limited,
E.E. Shafford, Mgr., East Broughton, P. Q.

The Martin-Bennett Asbestos Mines, Limited,
H. E. Peters, Secretary, Thetford Mines, P. Q.

Windsor Asbestos Company Limited,
Windsor, Ont.

Wotton Asbestos Co.,
c/o Léon Sohier, P.O. Box 42, Station C, Montreal.

SILVER

Weedon Mining Company,
L. D. Adams, Manager, Weedon, P. Q.

Eustis Mining Co., Limited,
F. M. Passow, Manager, Eustis, P. Q.

CHROME

P. E. Beaudoin,
Thetford Mines, P. Q.

Lucius Beebe & Sons,
129 South St., Boston, Mass., U.S.A.

Black Lake Asbestos & Chrome Co., Limited,
J. E. Murphy, Mgr., Black Lake, P. Q.

Dominion Mines & Quarries, Limited,
Dominion Bank Building, Toronto, Ont.

Jos. M. Johnson,
Black Lake, P. Q.

The Fletcher Pulp & Lumber Co., Limited,
H. Bruce Fletcher, Secretary, Sherbrooke, P. Q.

The Martin-Bennett Asbestos Mines, Limited,
H. E. Peters, Secretary, Thetford Mines, P. Q.

David Wilson,
Sherbrooke, P. Q.

W. J. Woolsey,
Thetford Mines, P. Q.

COPPER

Eustis Mining Company,
F. M. Passow, Mgr., Eustis, P. Q.

La Mine d'Or et Cuivre,
c-o P. E. Beaudoin, Thetford Mines, P. Q.

A. O. Norton,
W. Jenkins, Manager, Coaticook, P. Q.

N. S. Parker,
Eastman, P. Q.

Pierre Tétreault,
416 Power Building, Montreal.

Weedon Mining Co., Limited,
L. D. Adams, Pres., 609 Eastern Townships Bank Bldg., Montreal.

MINERAL WATER

Abenakis Mineral Spring Co., Limited,
W. E. Watt, Manager, Abenakis Springs, P. Q.

Chrs. E. Bédard & Dion Cie,
22Bigaouette Avenue, Quebec, Que.

Alfred Ferland,
1661 rue Bordeaux, Montreal.

Veillet & Frère,
Ste. Geneviève, Batiscan Co., P. Q.

Gurd & Co., Limited,
74 Bleury Street, Montreal, P. Q.

Lyall Trenholm & MacDonall,
Montreal West, P. Q.

Radnor Water Co.,
Geo. C. Kemp, Manager, Mark Fisher Building, Montreal, P. Q.

Cyprien Roy,
St. Germain, Co. Kamouraska, P. Q.

St. Léon Mineral Water Co.,
R. W. Nebb, Mgr., Toronto St., Toronto, Ont.

M. Timmons & Son,
Côte d'Abraham, Quebec, Que.

MAGNESITE

Dominion Magnesite Co.,
Calumet, P. Q.

Fitzsimons & Boshart,
14 Metcalfe St., Ottawa.

The Grenville Lumber Co.,
C. Laurin, 112 St. James St., Montreal

North American Magnesite Co.,
c-o H. J. Ross, Room 301, 180 St. James, Montreal.

Scottish-Canadian Magnesite Co., Reg'd.,
55 St. Francis Xavier St., Montreal.

IRON & TITANIC IRON

American Titanic Iron Co.,
c-o Hon. S. N. Parent, Parliament Bldg., Quebec.

Baie St. Paul Titanic Iron Ore Mining Export Co.,
J. O. Paré, Mgr., Baie St. Paul, Charlevoix Co., P. Q.

The Canada Iron Corporation, Limited,
Mark Fisher Bldg., Montreal

General John Carson,
18 Royal Insurance Bldg., Montreal.

Manitou Iron Mining Co.,
Jos. E. Globensky, 364 University St., Montreal.

NATURAL GAS

The National Gas Co., of Canada,
c-o M. E. B. Devlin, Hull, P. Q.

The Canadian Natural Gas Co.,
P.O. Box 2072, Montreal.

GRAPHITE

Bell Graphite Co., Limited,
Box 185, Buckingham, P.Q.

The Canadian Graphite Co.,
T.W.P. Patterson, Mgr., Room 34, Coristine Building, Montreal.

Dominion Graphite Co.,
H. P. H. Brumell, Manager, Buckingham, P. Q.

Graphite Limited,
220 Board of Trade Building, Montreal, P.Q.

Peerless Graphite Co.,
32 Thorndale Terrace, Rochester, N.Y.

New Quebec Graphite Co., Limited,
A. Geister, Manager, Buckingham, P. Q.

MICA

William Argall,
Laurel, Co. Argenteuil, P. Q.

Beaver Mica Mfg., Co., Limited,
124 Rideau St., Ottawa, Ont.

Blackburn Brothers,
H. S. Forbes, Manager, 134 Wellington Street, Ottawa.

Capital Mica Co., Limited,
W. Ahearn, Manager, St. Pierre de Wakefield, P. Q.

La Compagnie Minière de Mica Blanc,
1 Beaver Hall Hill, Montreal.

J. A. Chenevert,
c-o Le Courrier, Sorel, P. Q.

William Cleland,
Bouchette, Co., Wright, P. Q.

Cross & Wilson,
Cascades, Hull, P.Q.

H. T. Flynn,
108 Montcalm Street, Hull, P. Q.

J. B. Gauthier,
Box 226, Buckingham, P. Q.

J. B. Gorman,
Box 166, Buckingham, P. Q.

Laurentide Mica Co., Limited,
corner Bridge and Queen Streets, Ottawa.

The Loughborough Mining Co.,
N. J. Sproule, Mgr., c-o G. W. McNaughton, Sydenham, Ont.

R. J. McGlashan,
Wilson's Corners, Co., Wright, P. Q.

Adelard Morin,
Val des Bois, Labelle Co.

O'Brien & Fowler,
Bush Winning, Mgr., Rideau St., Ottawa.

W. L. Parker,
Buckingham, Co. Labelle, P. Q.

Louis Richard,
159-161 Arago St., Quebec, P.Q.

Ernest Shock,
Schwartz, P. Q.

Vavasour Mining Association,
22 Metcalfe Street, Ottawa, Ont.

Wallingford Bros.,
Perkins, P.Q.

Wallingford Mica & Mining Co.,
41 Vaughan Street, Ottawa, Ont.

Edward Watts,
19 Chestnut Park, Toronto, Ont.

Webster & Co.,
274 Stewart Street, Ottawa, Ont.

MOLYBDENITE

General John Carson,
18 Royal Insurance Bldg., Montreal

The Height of Land Mining Co.,
S. P. Wilson, Manager, 316 St. James Street, Montreal.

The St. Maurice Syndicate,
c-o A. E. Doucet, Quebec.

GOLD

Champs d'Or Rigaud-Vaudreuil,
Chambre 425, Transportation Building, Montreal.

Eustis Mining Co.,
F. M. Passow, Manager, Eustis, P. Q.

The Mountain Creek Gold Fields Limited,
Victoria Bldg., 52 Victoria Sq., Montreal.

Weedon Mining Co., Limited,
L. D. Adams, Manager, 609 Eastern Townships Bank Bldg., Montreal.

PHOSPHATE

Blackburn Bros.,
H. L. Forbes, Manager, 134 Wellington St., Ottawa.

J. G. Higginson,
Buckingham, P. Q.

O'Brien & Fowler,
Bush Winning, Manager, Rideau St., Ottawa.

Papineau Lumber Co., Limited,
H. T. Tétreau, Manager, Papineauville, Co. Labelle, P. Q.

Wallingford Mica & Mining Co.,
Perkins, P. Q.

Edward Watts,
19 Chestnut Park, Toronto.

OCHRE

Thos. H. Argall,
P.O. Box No. 2, Three Rivers, P. Q.

Canada Paint Co., Limited,
Jos. Bradley, Manager, Red Mill, P. Q.

Champlain Oxide Co.,
P. D. Carignan, Manager, Three Rivers, P. Q.

François Ouellet,
Ste-Gertrude, Co. Nicolet, P. Q.

SAND

The Beaupré Sand Co., Reg'd,
407 St. Valier Street, Quebec.

Delphis Beausejour,
Mont Rolland, P. Q.

Robert Boa,
Hillhead, Argenteuil Co., P. Q.

The Bonner Sand & Ballast Co.,
South Durham, P. Q.

The British Sand & Gravel Co.,
F. Forest, Joliette.

Canadian Sand & Gravel Co.,
Richmond and William Sts., Montreal.

Cement Products Co., of Canada, Limited,
104 Mountain Hill, Quebec.

Compagnie Sable Union Limitée,
105 Dalhousie St., Quebec.

Cumming Lawlor Sand & Supply Co.,
c-o H. F. Cumming, 258 Ottawa Street, Montreal.

Dominion Sand & Stone Co., Limited,
702 Canadian Express Building, Montreal.

Francis Hankin, Co.,
201 Coristine Building, Montreal.

Imperial Sand & Gravel Co.,
Joliette, P.Q.

Keystone Wall Plaster Co.,
Ste. Thérèse de Blainville, P. Q.

Joseph Labrecque,
Lanoraie, P. Q.

Laurentian Sand & Gravel Co.,
St. Gabriel de Brandon, Co. Berthier, P. Q.

Arthur Letourneau,
St. Remi, Napierville, P. Q.

Melançon Frère,
Grand Mère, Champlain Co.

Jules Miller,
300 St. Francis Street, Quebec.

Montreal Sand & Gravel Co.,
270 Ottawa Street, Montreal.

Quebec Central Ry.,
Sherbrooke, P. Q.

Moise Robidoux,
Yamaska, P. Q.

Royal Moulding Sand & Gravel Co.,
St. Félix de Valois, P. Q.

The Standard Sand & Gravel Co., Limited,
P.O. Box 2652, Montreal.

Napoléon St. Louis,
Fontarabie, Maskinougé, Co. P. Q.

The Touzin Sand Co.,
74 Common Street, Montreal.

Villeneuve & Co.,
St. Jerome, Co. Terrebonne, P. Q.

The Quebec, Montreal & Southern Ry., Co.,
Lanoraie, P. Q.

United Supply Co.,
173 Bleury Street, Montreal.

TALC

J. N. Martel,
Belmina, Wolfe Co., P. Q.

Geo. R. Pibus,
Knowlton, P. Q.

PEAT

Peat Industries Limited,
Imperial Bank Chambers, Montreal.

ZINC & LEAD

The Calumet Zinc & Lead Co.,
Geo. E. Murphy, Bryson, P. Q.

The Laurentide Mining Co.,
Notre-Dame des Anges, Portneuf Co., P. Q.

The New Richmond Prospecting & Mining Co.,
Little Cascapedia, P.Q.

Pierre Tétreault,
Room 416, Power Bldg., Montreal.

Weedon Mining Company, Limited,
Notre-Dame-des-Anges, Portneuf County, P.Q.

GLASS SAND

Dominion Glass Co., Limited,
Royal Trust Bldg, Montreal.

National Silica Sand,
11 St. Sacrement St., Montreal.

SLATE

Fraser & Davis,
New Rockland, P. Q.

The New Rockland Slate Co.,
Room 408, Merchants Bank Building, 205 St. James St., Montreal.

BRICK

Paul Anctil,
Rivière du Loup, P. Q.

N. L. Auger,
Ville de St. Tite, Champlain Co.

J. J. Beaudet,
St. Jean Deschaillons, P. Q.

Napoleon Belanger,
Plessisville, P. Q.

W. D. Bell,
1286 rue St. Valier, Quebec.

Narcisse Blais,
12 Marie Incarnation St., Quebec.

Wilfrid Cantin,
51 Marie Incarnation St., Quebec.

Victor Charland,
St. Jean Deschaillons, P. Q.

The Citadel Brick & Paving Block Co., Limited,
P. Galarneau, Manager, 42 Dalhousie St., Quebec.

Pierre Desjardins & Co.,
Ste Thérèse de Blainville, P. Q.

J. B. Desroberts,
St. Jean Deschaillons, P. Q.

Joseph Desrochers,
Warwick, P. Q.

Olivier Danville,
St. Casimir, P. Q.

Dupuis & Boutet,
Ste Thècle, P. Q.

The Eastern Townships Brick & Mfg., Co.,
Lennoxville, P. Q.

François Xavier Grenon,
25 rue Marie de l'Incarnation, Quebec.

David F. Hodgins,
Box 87, Shawville, P. Q.

Lachute Brick Works,
Lachute, Co. Argenteuil, P. Q.

Lafontaine & Martel,
St-Tite, Co. Champlain, P. Q.

Alexandre Laliberté,
St. Jean Deschaillons, P. Q.

Laliberté & Potvin,
St. Jean Deschaillons, P. Q.

Evang. Laliberté,
St. Jean Deschaillions, P. Q.

Lucien Laliberté,
St. Jean Deschaillons, P. Q.

Stanislas Laliberté,
St. Jean Deschaillons, P. Q.

Edmond Lapointe,
Acton Vale, Co., Bagot, P. Q.

Trefflé Leclerc,
Ste Anne des Plaines, P. Q.

Amédée Mathieu,
Victoriaville, P. Q.

Michel Mathieu,
Sorel, Co., Richelieu, P.Q.

Alex. Mills,
Ormstown, Chatauguay.

National Brick Co. of Laprairie, Limited,
10 Victoria Square, Montreal.

Elie Paradis,
St. Raymond, Co. Portneuf, P. Q.

Paradis & Létourneau,
Stadacona, Quebec.

Alderic Paris,
St. Jean Deschaillons, P. Q.

Philippe Potvin,
St. Jean Deschaillons, P. Q.

Proulx Brothers,
Richmond, P. Q.

The Sherbrooke Tile & Brick Co.,
Record Block, Sherbrooke, P. Q.

The St. Lawrence Brick Co., Limited,
La Presse Building, Montreal, P. Q.

Emile Théroux,
Mitchell, Sta., P. Q.

Joseph Tondreau,
St. Eugène, L'Islet, P. Q.

SAND-LIME BRICK

The Canada Brick Co., Limited,
Transportation Bldg., Montreal.

The Brick & Tile Co. of Canada,
J. A. Brodeur, Mgr., Pointe aux Trembles, near Montreal, P. Q.

LIMESTONE

Anderson Ste. Marie Stone Co.,
Nazareth and Ottawa Sts., Montreal.

Adolphe Barron,
La Carrière, Bagot, Co.

Jos. P. Beaudry,
Joliette, P. Q.

Bessette & Gagnon,
P.O. Box 428, St. John's, P. Q.

Elie Bigras,
Village St. Martin, Laval, P. Q.

David Breault,
St. Jean, P. Q.

The Canada Iron Corporation Limited,
Mark Fisher Bldg., Montreal.

Canada Iron Foundries Limited,
Imperial Bk. Bldg., Montreal.

Ferdinand Caron,
Village Bélanger, Laval, P. Q.

Joseph Charbonneau,
3020 rue St. Hubert, Montreal.

Alf. Chartrand,
Village Bélanger, Laval, P. Q.

Chateauvert Quarry Co., Reg'd,
52 St. Paul Street, Quebec, Que.

The Church-Ross Road Co., Limited,
40 Hospital St., Montreal.

La Cie de Briques de Québec, Limitée,
Beauport, Que.

La Cie des Carrières,
St. Marc des Carrières, P. Q.

Alfred Cossette,
Valleyfield, P. Q.

Albert Cousineau,
288 rue de Gaspé, Montreal.

Gaspard Desond,
St. Cuthbert, Co. Berthier, P. Q.

The L. Dèguire Quarry Co.,
St. Laurent, near Montreal, P. Q.

Rock Delcourt,
Village Bélanger, Laval, P. Q.

The DeLorimier Quarry Co.,
1952 Iberville St., Montreal.

Frank Deraiche,
Chandler, Gaspé.

The Deschambault Stone Co.,
St. Marc des Carrières, P. Q.

Pite Desroches,
Joliette, P. Q.

R. C. Dickson,
601 Monsabré, Montreal.

The Federal Stone & Supply Co., Limited,
213 Sussex St., Ottawa.

The Fire Proof Stone Co., Inc.,
2680 Masson St., Montreal.

R. Frenette,
St. Vincent de Paul, Laval.

Martin Gagnon,
2690 Chateaubriand Station, Montreal.

General Contracting Co., Limited,
357 Kensington, Montreal.

Jos. Gingras,
St. Marc des Carrières, P. Q.

Paul Gingras,
Cap St. Martin, Co. Laval, P. Q.

Joseph Gravel,
488 Duluth Ave., East, Montreal.

Institution des Sourds-Muets,
1941 St. Dominique St., Montreal.

Jackson Bros.,
Batiscan, Portneuf.

Kennedy Construction Co., Limited,
704 Shaughnessy Bldg., Montreal.

Aldéric Labelle,
Village Bélanger, Co. Laval, P. Q.

Louis Labelle & Cie.,
St. François de Salle, P. Q.

The Félix Labelle Quarry Co., Limited,
Terrebonne, P. Q.

Elz. Laforce,
St. Marc des Carrières, P. Q.

Ovide Lapierre,
830 Chemin de la Petite Côte, Montreal.

Jos. Lapointe.
St. Dominique, P. Q.

Laurentian Stone Co., Limited,
53 rue Albert, Hull.

Laurin & Leitch,
5 Beaver Hall, Sq., Montreal.

The Laval Quarry Co.,
St. Frs. de Sales, P. Q.

Aurélien Laviolette,
Laval des Rapides, P. Q.

G. H. Leahy,
128 Valois Street, Montreal.

Victor Lecrenier,
Cap St. Martin, P. Q.

Leduc & de Repentigny,
St. Timothée, Châteauguay Co.

Augustin Leroux,
St. Vincent de Paul, P. Q.

Olivier Limoges,
477 Papineau St., Montreal.

Narcisse Lord,
St. Jean, P. Q.

O. Martineau & Fils, Limited,
371 Marie Anne Ave., Montreal.

Joseph Monette,
Village Bélanger, P. Q.

Montreal Concrete Works Co., Limited,
225 St. James Street, Montreal.

Mount Royal Tunnel & Terminal Co., Limited,
c-o Mackenzie & Mann Limited, Toronto.

Damase Naud,
St. Marc des Carrières, P. Q.

Damien Paquette,
Village Bélanger, Laval.

Levi Paquette,
St. Elzéar, Laval.

Plouffe & Lagacé,
Cartierville, P. Q.

W. J. Poupore & Co.,
Room 200, McGill Bldg., Montreal.

Quinlan, Robertson & Miller.
357 Kensington Ave., Montreal.

Jos. Rhéaume,
2855 Boulevard Rosemont, Montreal.

Rogers & Quirk,
1701 Iberville Street, Montreal.

Shawinigan Quarry & Construction Co.,
4 Hart St., Three Rivers, P. Q.

A. Simard,
Chambly, P. Q.

R. F. Smith Construction Co.,
27 Hillside St., Westmount.

The St. Laurent Quarry Co., Limited,
Cap St. Martin, Co. Laval, P. Q.

Stinson-Reeb Builders Supply Co., Limited,
Eastern Township Bank Building, Montreal.

Pierre Tétreault,
416 Power Bldg., Montreal.

Villeray Quarry Co.,
838 Du Rosaire Street, Montreal.

Vinet & Durand,
4615 Notre-Dame St. East, Montreal.

Wright & Co.,
267 O'Connor Street, Hull, P. Q.

LIME

Arnaud & Beaudry,
Joliette, P. Q.

Adolphe Barron,
La Carrières, Bagot.

Arthur Boivin,
Pont Rouge, Portneuf, P. Q.

R. B. Carswell,
Bryson, P. Q.

Dominion Lime Co.,
Sherbrooke, P. Q.

C. A. Gervais,
1460 Cadieux St., Montreal.

Ephrem Lavallée,
La Chaloupe, Co. Joliette, P. Q.

Olivier Limoges,
477 Papineau Ave., Montreal.

Z. O. Limoges,
40 Poupart St., Montreal.

Missisquoi Marble Limited,
Philipsburg, Co. Missisquoi, P. Q.

Thos. McCambly,
Kazubazua, P. Q.

Montreal Lime Co.,
31 Prenoveau St., Montreal.

Naud & Marquis,
St. Marc des Carrières, P. Q.

Placide Sanche,
Côte St. Louis, Ste. Thérèse, Co. Terrebonne, P. Q.

Sovereign Lime Works,
Chambre 627, 120 St. James St., Montreal.

Standard Lime Co., Limited,
St. Paul, Co. Joliette, P. Q.

Wright & Co., Inc.,
267 O'Connor and Hull Streets, Ottawa, Ont.

SANDSTONE

H. T. Routhly,
Haileybury, Ont.

Montreal Sand & Gravel Co., Limited,
270 rue Ottawa, Montreal.

The Sydney Kirby Co.,
213 Sussex St., Ottawa.

CEMENT

Canada Cement Co., Limited,
F. P. Jones, Manager, Herald Building, Montreal.

FELDSPAR

S. Carsley, & Co.,
151 Notre-Dame St. W., Montreal.

The Dominion Mining Syndicate,
c-o O'Brien & Fowler,
Bush Winning, Mgr., Rideau Street, Ottawa.

Eureka Flint & Spar Co.,
Trenton, N.J.

GRANITE

Argenteuil Granite Co.,
42-44 Craig St., W., Montreal.

The B. & L. Granite Co., Limited,
20 St. James St., Montreal.

James Brodie,
Graniteville, P. Q.

James Brodie & Son,
Iberville, Jct., P. Q.

La Compagnie de Granit de Mégantic, Limitée,
Lac Mégantic, P. Q.

La Compagnie de Granit du Nord Limitée,
c-o M. Desautels 30 St. James St., Montreal.

M.P. & J. T. Davis,
14 St. Peter St., Quebec.

Augustin Delisle,
Rivière à Pierre, P. Q.

Alex. Doyer,
Rivière à Pierre, P. Q.

Dumas & Frère,
Rivière à Pierre, P.Q.

William Duncan,
Graniteville, P. Q.

John Dupras,
Marion, Labelle Co., P. Q.

W. M. Hazelton,
Beebe Jct., Co. Stanstead P. Q.

The Laurentian Granite Co., Limited,
Room 82, 224 St. James St., Montreal.

National Battlefields Commission
2 Cook St., Quebec.

S. B. Norton,
Beebe Jct., Co. Stanstead, P. Q.

Jos. Perron,
Rivière à Pierre, P.Q.

R. A. Rideker,
Graniteville, P. Q.

Rigaud Granite Co., Limited,
137 McGill St., Montreal.

Stanstead Granite Quarries Co., Limited,
Beebe Jct. Co. Stanstead, P. Q.

Fortunat Voyer,
Rivière à Pierre, P. Q.

Léo. Lafond,
2611 Hutchison St., Montreal.

KAOLIN

Canadian China Clay Co., Limited,
P.O. Box 292, Montreal.

St. Remi Kaolin Co.,
Campbell Bldg., Elmire St., Montreal.

MARBLE

La Cie de Marbre du Canada,
c-o Victor Côté, 153 St. Hélène St., Quebec.

Dominion Marble Co., Limited,
P.O.Box 1166, Montreal.

Missisquoi Marble Limited,
Philipsburg, P. Q.

The Pontiac Marble & Lime Co., Limited,
193 Sparks Street, Ottawa.

POTTERY

W. B. Bell,
1286 St. Valier St., Quebec.

Canada Stone Ware Works,
c-o E. L. Farrar, Iberville, P. Q.

Canadian Trenton Potteries Co., Limited,
St. John's, P. Q.

The Citadel Brick & Paving Blocks Co., Limited,
42 Dalhousie St., Quebec.

Montreal Fire-Brick Works Limited,
399 St. Ambroise St., Montreal.

Montreal Terra-Cotta Lumber Co.,
Lakeside, P. Q.

Poterie Dion Enrg.,
40 Dominion Bldg., Quebec.

Standard Clay Products Limited,
St. John's P. Q.

STATISTICS OF ACCIDENTS

IN MINES AND QUARRIES REPORTED DURING THE YEAR 1915.

A. O. Dufresne.

A glance at the tables below shows that the number of accidents whereof the Bureau of Mines received notice during the year 1915 is larger than that of the previous year. In 1914, the statistics gave 139 accidents, nine of which were fatal, while in the past year 173 accidents were recorded, 13 of which had fatal consequences. If we take into consideration the average number of workmen employed in mines and quarries during the past two years, we find that, apparently, a great many accidents occured in 1915. We must, however, take into account the fact that last year the compilation of the statistics in connection with accidents was made in a much more regular manner than in the previous years. Many cases, which would formerly have remained unnoticed, were reported to us. We are pleased to mention here the assistance given us in connection with such work of compilation, by the coroners who notify the superintendent of the Bureau of Mines whenever an inquest is held in a case of violent death in a mine, quarry, sand-pit or clay-pit.

The period of stagnation following the breaking out of hostilities in Europe in the year 1914, still made itself somewhat felt in the mining industry of the Province of Quebec during the first two months of 1915. When the asbestos, chromic iron, magnesite and copper market became stronger, the greatest activity prevailed during the remainder of the year and everything tends to show that the year 1916 will greatly surpass 1915. It is otherwise with building materials, the production whereof has considerably decreased and the number of workmen in that branch of the mining industry has diminished.

During the year 1915, the average number of workmen employed in the mines, quarries, clay-pits, sand-pits, ore-dressing works, etc., of the Province of Quebec was 5,767. These figures correspond to

the number of men who worked 300 days or the "man-year." which is the basis of our statistics. It should be observed here that several of the provinces of Canada do not make out their accident statistics on this basis; for their compilation, they take the total number of men who have found employment in mines or the concentrators and mills connected with them, during the year. Any person comparing the statistical figures of two provinces must therefore bear in mind this difference in the compilation of the tables.

In 1915, 7,989 men gave 1,757,736 days work while, in 1914, 9,168 worked for a total of 2,087,063 days. The total number of days work divided by 300 (the number of working days in the year) gives us men-year: 5,767. This represents a decrease of 1,189. or 17% as compared with the previous year.

The workmen's wages in 1914 amounted to $4,365,439 as compared with $3,419,857 in 1915, being a decrease of $945,582 or 22%. The average wages in 1913, 1914 and 1915 were $626, $627 and $593 respectively.

TABLE I

Persons employed in the Mines, Quarries and Concentrating Mills in the Province of Quebec in 1915

Mines, Quarries and Mills	Number of days labour	Number of men calculated on 300 days
Asbestos (quarries and mills)	675,429	2,251
Copper and Pyrite, Silver, Gold	89,414	299
Chrome, Titaniferous Ore, Zinc and Lead	60,920	203
Feldspar, Pottery, Kaolin, Quartz, Phonolithe (pits and mills)	50,902	170
Graphite, Mica, Phosphate	24,512	80
Magnesite	17,308	58
Mineral Water (Springs and works)	10,699	35
Ochre	9,698	32
Brick (clay-pits and brickyards)	113,778	379
Cement (quarries and mills)	99,679	332
Granite	29,757	106
Lime (Quarries and Kilns)	45,686	149
Limestone (Quarries and Dressing Works)	456,240	1,426
Marble, Slate and Sandstone	43,563	146
Sand (Pit and River)	30,151	101
	1,757,736	5,767

TABLE II

Workmen in	Number	Salaries	Number of Days' work	Number of men on 300 days' basis
Producing Mines.....	3,314	$1,488,588	879,277	2,931
Non-producing Mines..	144	35,294	17,531	59
Totals.....	3,458	$1,523,882	896,808	2,990

The labour expended on assessment work exacted for retaining rights on lands leased under the provisions of the Mining Act is not included in this table.

TABLE III

Workmen	Number of men on 300 days' basis	Accidents		Total	Per 1,000 employed
		Fatal	Non-fatal		
Mines.....	2990	10	141	151	50
Quarries.....	2777	3	19	22	8
Totals.....	5767	13	160	173	58

Table III. shows the number of workmen employed in mines and quarries, and the number of fatal and non-fatal accidents. In this table the word "quarry" includes clay-pits and sand-pits.

By non-fatal accident, the Bureau of Mines of the Province of Quebec means any accident which incapacitates a man for work for a period of ten days or more.

For every 1,000 men-year in the mining industry in the Province of Quebec, we record 2.25 fatal accidents. This year we had three fatal accidents in quarries while none were reported in 1914.

In the mines there were, in 1914, nine fatal accidents for 3,046 men employed, a proportion of 2.95 per 1,000. In 1915 we had 2,990 men employed in mines and ten fatal accidents, a proportion of 3.34 per 1,000.

TABLE IV

Accidents in Mines, Quarries and Mills of the Province of Quebec for 1915.

	Fatal		Non-fatal		Totals	
MINES:	No.	%	No.	%	No.	%
Underground	4	2.3	5	2.9	9	5.2
Open Pits	6	3.5	107	61.8	113	65.3
Surface	0	0.0	11	6.3	11	6.3
	10	5.8	123	70.0	133	76.8
QUARRIES:						
Pits	2	1.2	13	7.5	15	8.7
Surface	1	0.6	1	0.6	2	1.2
	3	1.8	14	8.1	17	9.9
MILLS:						
Mills	0	0.0	14	8.1	14	8.1
Shops	0	0.0	9	5.2	9	5.2
	0	0.0	23	13.3	23	13.3
Totals	13	7.6	160	92.4	173	100.0

TABLE V

Analysis of fatal accidents in the Province of Quebec, 1915.

	Underground		Open Pits		Total	
MINES:	No.	%	No.	%	No.	%
Falls of ground	2	15	5	38	7	53
Explosives	1	8	..	..	1	8
Cable-Derrick	..	..	1	8	1	8
Shaft	1	8	..	..	1	8
	4	31	6	46	10	77
MILLS:	No fatal accidents in Mills in 1915					
QUARRIES:						
Explosives	2	15	..	..	..	..
Boom-Derrick	1	8	..	..	..	..
	3	23	..	..	3	23
					13	=100

We recorded one fatal accident in concentration works in 1914, while there was not a single one in 1915.

Table V shows that rock slides and falls are responsible for more than one-half of the loss of life and that explosives account for 23% of the same.

We must also attribute the greater number of non-fatal accidents to rock-slides and rock-falls. The others are due to cable-derricks, to the handling of ore-cars, to various pieces of machinery in the mills, to falling objects. Some accidents may have been caused by dangerous working methods. We deem it fairer, however, to attribute them to the following causes: lack of discipline; the workmen's imprudence; their wish to run risks rather than make an extra effort by going a few steps to avoid a falling rock; their recklessness in passing beneath the box of a cable-derrick or other suspended machine; their habit of trusting to their eyes to judge of the solidity of the roof of their working places rather than by sounding it with a tool; the tendency to assume risks even if they endanger their lives, such as battering down arches of fallen rock rather than removing the rocks one by one; walking on the railway track knowing that cars are running; to save time in drilling they do not hesitate to use the bottom of a hole already fired; machinery is oiled or greased while in motion; too heavy loads are carried to save going over the same ground twice. In some mines and quarries, stones are broken with hammers. This should not be allowed, it too frequently happens that pieces of stone strike the workmen in their faces or the eyes, and there is another one-eyed man. In other places an iron wedge is used instead, which is far preferable. Unfortunately, through clumsiness, the striker sometimes misses the wedge and hits his companion's wrist. To avoid such risk, an iron rod about twenty inches long is used in some places to hold the wedge. This has given full satisfaction.

The general table of non-fatal accidents in 1915 shows that two accidents were caused by belts and pulleys in mills. A carpenter had a bone of his little finger of the right hand broken when the latter was caught between a belt and the pulley around which it ran. A sweeper, working near a pulley in motion, had the middle finger of his right hand injured when the broom was snatched out of his hands by the pulley.

TABLE VI

Analysis of non-fatal accidents in mines, quarries and mills of the Province of Quebec in 1915.

Mines:	Under-ground	Open pits	Surface	Total	
				No.	%
Rock falls and slides	1	49	..	50	40.7
Cable-Derrick	..	29	..	29	23.6
Cars and track	1	7	8	16	13.1
Breaking Stone	..	9	..	9	7.3
Falls	1	6	1	8	6.5
Falls of objects	..	3	1	4	3.2
Explosives	1	2	..	3	2.4
Drilling	1	1	..	2	1.6
Ladders and Stairways	..	1	..	1	0.8
Nails	..	..	1	1	0.8
	5	107	11	123	100.00
Quarries:					
Rock Falls and Slides	..	3	..	3	21.4
Explosives	..	3	..	3	21.4
Cars and Tracks	..	3	..	3	21.4
Breaking Stone (hammer)	..	2	..	2	14.2
Nails	..	..	1	1	7.2
Derricks	..	1	..	1	7.2
Falls	..	1	..	1	7.2
	..	13	1	14	100.00
Mills and Concentrators:		Concen-trators	Machine Shops		
Machines		9	1	10	43.5
Falls of Objects		2	7	9	39.2
Belts and Pulleys		2	..	2	8.7
Falls		1	..	1	4.3
Unclassified		..	1	1	4.3
		14	9	23	100.00

We are glad to say that some companies have undertaken a systematic campaign for the prevention of accidents. The general plan followed consists in getting all the head foremen and gang-foremen together periodically to show them the measures to be taken for preventing the recurring of accidents and remind them of the

methods already suggested. All machinery in use is inspected at regular periods. All dangerous places are guarded by protective appliances; thus, openings in floors are closed, gearing-wheels are covered, etc. In some mines special precautions are taken, thus in most open-workings and large quarries blasts are fired by electricity. At the King mine, those in charge of the hoists of cable-derricks get their orders directly from the gang-foreman in the bottom of the pit by means of an electric bell. At the same mine they have begun driving an inclined tunnel several hundred feet long from the open workings to the main street. This tunnel will be reserved exclusively for the workmen and will always give them a means of communication in good order. It may also be added that the company working that mine has made great changes in its plant during the year 1915. It has replaced the thirteen small cable-derricks by four having double the capacity. With fewer apparatus working overhead and a limited number of boxes at the bottom of the pit, we expect to have a considerable decrease in accidents caused by cable-derricks in that mine. It should also be stated that the boxes empty automatically and the trucks are loaded in the same manner. In some p'aces around the open-workings, the thick layer of earth covering the rock has been removed at great expense, Radical changes are being made in the working of several mines, thus cable-derricks are being replaced by inclined planes and the trucks are loaded by steam-shovels directly at the bottom of the mine.

At the Jeffrey mine, in order to avoid accidents likely to cause death, to damage the plant or cause loss of time, a new kind of carrier made of small U-shaped steel beams has been adopted and material improvements have been made in other parts of the cable derricks. The apparatus consists of a suspension steel cable one inch and a half in diameter, specially made so as to avoid strains from the twisting of the cable. There is a 5-8 inch hauling rope running on sheaves arranged in a new way. The hoisting block for the box is raised by three strands of 5-8 inch cable while there were only two in the old pattern. With this arrangement, if the cable should break as it occasionally happens, it is impossib'e for the car to fall on the lower anchorage. If, with all the above arrangements, the hauling cable should break the engineer at the hoist can stop the car by merely putting on the brakes.

TABLE VII

The Age of the Injured, 1915.

	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	Un-known	Total
Non-Fatal..	25	28	20	20	19	15	9	9	11	2	2	160
Fatal.....	3	1	2	..	5	2	..	..	..	..	..	13
Total....	28	29	22	20	24	17	9	9	11	2	2	173

TABLE VIII

FALLS OF ROCK BY MONTH, 1915.

NON-FATAL	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Underground												1	1
Open Pits	2	1	2	8	2	5	5	4	6	4	5	5	49
Quarries			1			1					1		3
FATAL													
Underground												2	2
Open Pits		1					3				1		5
Total	2	2	3	8	2	6	8	4	6	4	7	8	60

By table VII it will be seen that workmen between 56 and 60 years of age are responsible for more accidents than the adjoining classes. Among that class we have eleven accidents this year while there were only ten last year.

As to rock falls and slides in open workings, the month of April still heads the list, as may be seen by table VIII. Heavy thaws occur during that month and the melting of the ice accumulated on the walls or sides loosens a quantity of pieces of rock which fall to the bottom of the cut. Companies which are careful of their workmen's lives, suspend operations for some days and clear the walls and side-slopes completely before allowing the men to go back to work.

STAIRS

Owing to the large number of open workings in the Province of Quebec, whose depth is constantly increasing—some of the asbestos pits are 250 feet deep—we deem it advisable to speak of the type of stairs which offers the greatest security while occasioning the least fatigue.

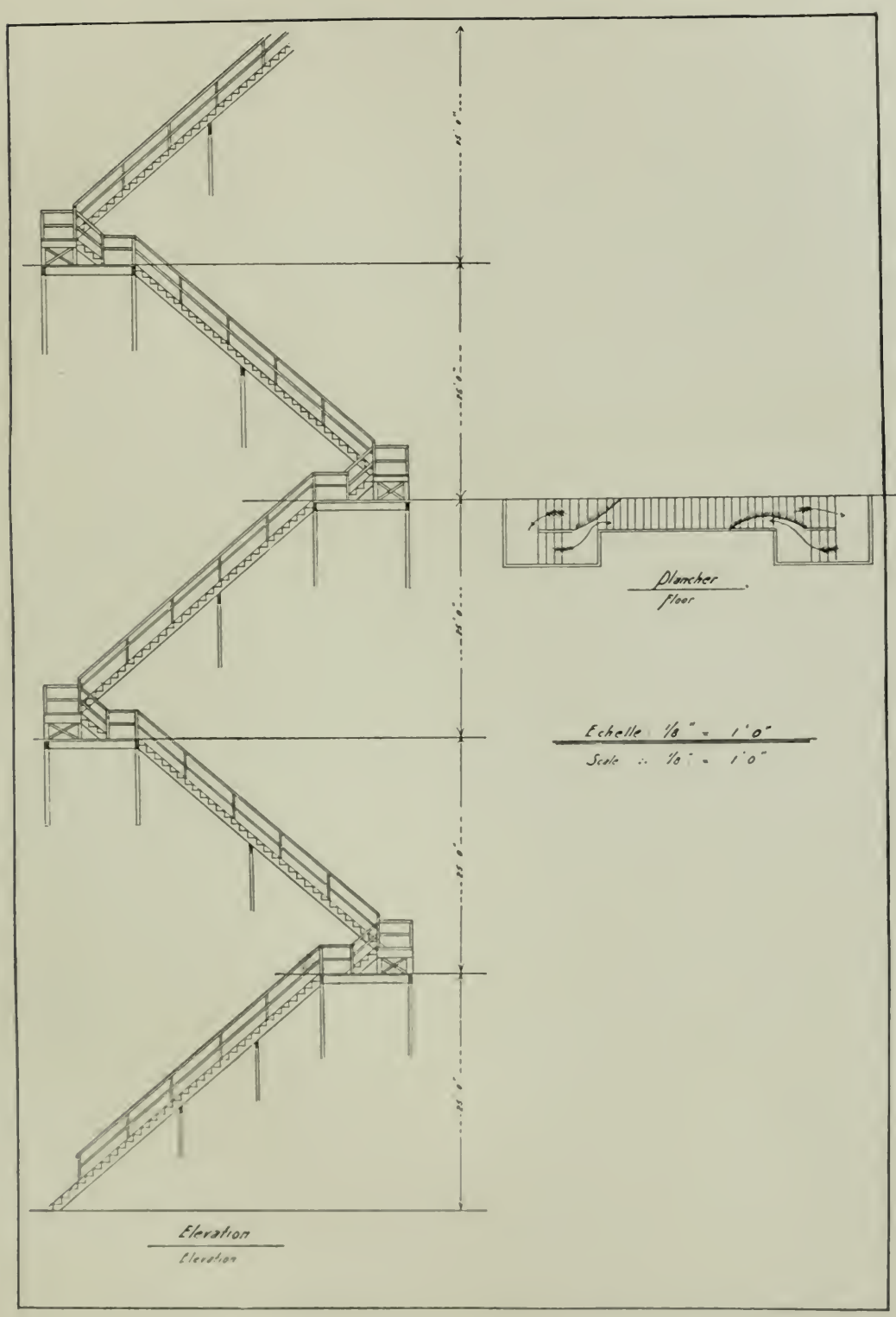
The mines and quarries where work is done in open workings and whose depth is such that access to the bottom can be had only by means of ladders or stairs, are generally of such extent that the ladders or stairs may be far enough from the place where the cutting or working is being done and sheltered from flying pieces of rock from blasting. They may, therefore, be of a permanent nature.

The stairs, shown in the figure below, are built along a vertical side of the open working. Each flight of steps touches the rock; the vertical distance between two landings should never exceed 25 feet; it is better that no flight should have more than 21 steps.

The breadth of the step plus the height of the riser should not exceed 18 nor be less than 17 inches. The minimum length of the step should be 10 inches. It is essential that the stairs be provided with a firmly secured hand-rail. The height of the latter, measured from the centre of the step at the upper part, must be 36 inches. It is a very bad practice to use ladders instead of stairs when the slope is under 50 degrees.*

A sketch of the type of stairs required for open workings is given opposite and we hope that operators will adopt this type when they put in new stairs.

*Universal Safety Standards.



Type of stairways for quarries and open-pits.

FATAL ACCIDENTS, 1915

No.	Date	Mine or Quarry	Name of Operator	Name of Injured	Age	Occupation	Nature of Injury	Cause of the Accident
1	Jan. 25	Eustis Mine	Eustis Mining Company	William Cleave	40	Trammer	Chest crushed in	An unusual noise heard caused the men to jump off the riding car in the slope. In the scramble Cleave got under the wheels and had his chest crushed in.
2	Feb. 3	Jeffrey Mine	The Asbestos & Asbestic Co., Limited	Nester Mykyukuk	27	Labourer	Severe fracture back of skull	By a rock rolling down from side of pit.
3	Mar. 11	Jeffrey Mine	The Asbestos & Asbestic Co., Limited	Alfred Filteau	39	Labourer	Fracture of 3rd and 4th cervical vertibrae	The brake on drum of hoisting engine of cable derrick broke, and the box struck victim on head.
4	May 31	Tétrault Mine	Weedon Mining Co., Ltd	Albert Proulx	19	Shoveler	Skull fractured	Drilling into missed hole.
5	July 10	King's Mine	Asbestos Corporation of Canada, Limited	Oneil Poirier	27	Labourer	Fracture of spine and cut in the abdomen	While taking down loose from side of pit a slide carried him to the bottom.
6	July 10	King's Mine	Asbestos Corporation of Canada, Limited	Alfred Letourneau	36	Labourer	Fracture of skull and all bones of face	While taking down loose from side of pit, a slide carried him to the bottom.
7	July 15	British Canadian	Asbestos Corporation of Canada, Limited	Romano Harbory	45	Labourer	Fractured skull	A piece of rock fell from side of pit, striking Harbory on the head.
8	July 30	Rosemont Quarry	O. Martineau & Fils, Ltée	L. Alphonse Liboiron	18	Driller	Burns and internal injuries	Premature explosion of dynamite charge.
9	Aug. 18	Lacombe Quarry	La Cie de Granit de Megantic Ltée	Antonio Lacroix	20	Labourer	Struck on the head	A boom was being lifted by a derrick when the chain slipped and boom fell on Lacroix.
10	Nov. 4	Voyer Quarry	F. Voyer & Frères	Tobie Garneau	43	Labourer	Struck on the head	By a piece of rock projected by a mine blast.
11	Nov. 20	Beaver Mine	Asbestos Corporation of Canada, Limited	Nazaire Remillard	38	Pit Labourer	Fatally crushed	By a piece of rock which was being loosened above him in the pit.
12	Dec. 3	Breeches Lake Mine, Lot C., Rg. I. Garthby	R. L. Stewart Patterson	Phileas Catellier	24	Labourer	Fractured base of skull	Fall of rock at entrance of drift.
13	Dec. 14	Eustis Mine	Eustis Mining Co.	Domenico Lucenti	36	Trammer	Fracture of skull	A piece of rock fell from roof of a stope while he was tramming.

25th February.—At the Eustis mine about 4.15 p.m. eighteen workmen, whose shift of work was over, were being hauled up by the riding car. Between the 25th and 26th levels, they heard an unusual and disquieting noise in front of the car probably caused by the cable swinging and striking the rollers and rails. They became frightened and in a moment of panic all except two jumped out of the car which was ascending at a moderate speed of about 250 feet per minute. Somebody gave the signal and the engineer in charge of the hoist immediately stopped the machine. The workmen, recovering from their fright, struck a light and found, about three feet from the car, the victim, Wm. Cleave, who was still conscious.

The unfortunate man had his chest crushed in, an arm broken and many contusions on the upper portion of his body.

Nobody knows how he was struck. It is very probable that he was hurled out of the car in the panic, that he rolled under it and had his chest crushed in some way not explained at the inquest.

There is reason to believe that the cause of the accident was the state of panic that prevailed for some moments.

VERDICT:—Accidental death.

On the 3rd February, 1915.—About one o'clock in the afternoon, at the Jeffrey mine, Asbestos, the gang, working for cable derrick No. 15 on the second bench, tried to remove a large piece of rock weighing over a ton which overhung the working at a height of eight feet. They tried at first to remove the rock by means of a chain suspended from the cable derrick. After some unsuccessful attempts, the gang foreman thought it would be better to arrange the chain differently. While this preliminary work was being done, he got on the piece of rock to carry out his new plan, while the victim, Nestor Mykyukuk, was performing the same work under the rock. The latter broke away before he could get clear. He had serious compound fractures of the skull, of an arm and of the right leg, also a wide cut in the abdomen and five ribs broken, according to the medical evidence.

VERDICT:—Accidental death due to the negligence of those in charge of the work.

On the 11th March 1915.—At the Jeffrey mine, Asbestos, a gang of men were working on the highest bench of the open pit, about thirty feet under the cable derrick. About ten o'clock in the forenoon, the signal to hoist the box was given; the latter was then near the cables, the engineer applied the brakes on the drum of the hoist on which the traction cable was wound. The brakes snapped and the pieces of the level arm flung the engineer against the side of the wall of the building. In spite of his diligence in working the friction clutch the derrick-box was stopped only two feet from the bench after striking Alfred Filteau on the head, fracturing two cervical vertebrae and killing him instantly.

The brake was broken in the anchored part under the base plate of the hoist. An examination of the break revealed that a flaw had existed for some time in the thread of the screw; rather fresh rust was observed over a space equal to a third of the section.

VERDICT:—Accidental death.

On the 31st March at 1.50 in the afternoon, at the Tetreault mine, Notre Dame des Anges, Albert Proulx was mortally, and Louis Kenty seriously wounded, by an explosion. It would appear that the bit of the drill met a miss-hole at the bottom of which some dynamite had remained, causing an explosion. Proulx, who was working about 20 feet from the front of the cut, was struck on the head and left shoulder by flying pieces of rock from the explosion.

It is hard to understand how Kenty did not notice the direction the bit of the drill was taking. He was perfectly acquainted with the place; he had himself, on the previous Saturday, drilled and loaded the hole where the missfire had taken place. Apparently, he did not examine the face of the cut when he went back to his work on Monday morning.

On the 10th July, at 1.25 in the afternoon, at the King mine, owned by the Asbestos Corporation of Canada Limited, an accident caused the death of Ovil Poirier and Alfred Létourneau. At 11.30 on the portion belonging to the King mine, of the ridge of rock separating the latter's pit from that of the Bell Asbestos Mines Co. eighty holes of an average depth of 14 feet, charged with ten pounds of dynamite at 40% were fired.

At 11.50, the foreman examined the spot. At one o'clock, a gang of 20 men was directed to roll down the pieces of rock. Ten men worked fastened to ropes held by their companions. At 1.20 p.m. a quantity of rock covering 40 x 75 feet, by a depth of 30 feet at the centre, slid off. Poirier and Letourneau were carried away. The medical examination showed Poirier had his chest crushed in and his neck broken, while Letoureau had several fractures of the skull, his chest crushed and a wide wound in the abdomen.

On the 15th July.—About one o'clock in the afternoon, at the British-Canadian Mine, Black Lake, Romano Arbovi was killed by a stone rolling from a heap. According to the evidence given at the inquest, a rock weighing between seven and eight pounds fell from the side of the open cut from 90 to 100 feet above.

The victim was struck on the back of the head, and the fracture of the skull caused instant death.

No blast had been fired for five days and the foreman in charge of the open working had examined the place every morning.

VERDICT:—Accidental death from fracture of the skull.

On the 30th July.—About 5.30 in the afternoon, at the Rosemont quarry owned by Messrs. Martineau & Son, three men were victims of an accident resulting from the tamping of a drill-hole. Louis Liboiron, 17 years of age, died from the effect of fatal burns on the face and of wounds all over his body; Elanie Romanuck, 40 years old, had his skull crushed in; Fred Belisle, 26 years old had his left leg fractured.

The drilling of two holes 24 feet deep, six inches in diameter, distant 20 feet from one another had just been completed. Two Clipper, Loomis Blast Hole drills, No. 4 E., are used for drilling blasts holes. The gang firing the blasts was preparing a charge to chamber the bottom of the hole, so as to make room for a heavy charge of dynamite. That first charge consisted of four cartridges, each containing 12 ½ pounds of Dominite powder at 50%. A No. 8 electric primer was put in the fourth cartridge. The usual pratice is to ram the first three cartridges to the bottom of the hole with

a wooden mallet measuring about 4 inches in diameter by 12 inches in length, attached to an iron rod 12 feet long suspended by a steel cable to the winch of the drill. The ramming is done by working the winch. The explosion occurred during that operation.

There are two theories as to the cause of the explosion. The first is the presence in one of the cartridges of some very sensitive explosive; the second that such a method of ramming cartridges is defective. The mallet used in ramming the explosive is too heavy and, falling as it does from a height of several feet, it breaks the cartridges, and it seems probable that the iron rod may have struck the dynamite as it dropped, thereby causing the explosion.

On the 18th August.—At the Lacombe quarry, St. Samuel de Whitton, a gang of labourers were loading the mast of a guy-derrick on a car. It had been lifted from the ground by means of a chain some distance from its centre of gravity, suspended from the pulley-block of a derrick. From information obtained on the spot, it would seem that one end of the mast struck the car, causing the chain to slip and the mast fell on Antoine Lacroix, breaking his left shoulder and throwing him on the ground. In falling he fractured his skull on a rail, causing instant death.

VERDICT:—Accidental death.

On the 20th November.—At the Beaver mine of the Asbestos Corporation of Canada Limited between a quarter-past and half-past seven in the morning, Nazaire Remillard, 38 years of age, was killed by a piece of rock weighing about three hundred pounds which rolled from a slope about 15 feet high.

It appears from the evidence at the inquest that, ten minutes before the accident, the gang foreman had ordered Remillard to move away because they were going to remove the rock that afterwards killed him, because it was dangerous to the men working at the foot of the slope. He stopped working, but did not move. He was warned twice again before the accident. When the rock began to slide down, his companions called out to him, he turned around, saw the rock and while trying to get away he fell over the box of a cable-derrick just as the rock crushed him. He died a few minutes after being brought to the surface. Medical examination revealed

comminuted fractures of the upper third of the right thigh and fracture of the bone of the pelvis, which caused death.

VERDICT:—Accidental death without blame to anybody.

On the 3rd December.—About eleven o'clock in the forenoon, on lot C. range I.S.E.; Garthby township, Edouard Goulet and Phileas Catellier were working at the entrance of an adit at the foot of a bluff, when a piece of the roof fell, killing Catellier instantly and severely wounding Goulet on the head. Goulet and Catellier, two farmers, had been working a deposit of chrome iron only since the last few days. They had drilled two holes in the roof at the entrance of the adit during the forenoon. After charging each of them with a cartridge and a half of dynamite, they fired the two blasts 10.30 a.m. The blasts, 8 feet apart, exploded with an interval of about a quarter of a minute. After the explosion they removed a large stone from the roof at the entrance. The accident occurred about forty minutes after the blasts were fired.

The adit, at the foot of a serpentine bluff about 40 feet high was 10 feet high, 10 wide and 10 deep. On examining the spot, the presence of numerous joints, some of which have a dip of about 60° towards the east was observed. From the eastern corner of the gallery another joint with about the same dip, but towards the west, formed a series of triangles with the first group of joints. The two blasts weakened the base supporting the prisms of rock between the joints. After the blasts, while removing a big piece of rock which they considered to be dangerous, they took away what might be deemed the key-stone of a vault supporting the central prism. The mass of rock fell on them only a few minutes after the key-stone was removed.

Phileas Catellier died instantly from fracture of the skull. Edouard Goulet received some cuts on the head.

On the 14th December.—At the Eustis mine, Dominique Lucenti an Italian about 37 years of age, was tramming at level 29, about 6.45 a.m., on the north side of the shaft, pushing a mine car towards the shaft bin with a companion. At the time of the accident, the victim was leaning out on one side of the car to see whether

there was anything in front that might block the wheels. At that moment a block of lean ore, measuring 3 ½ feet, by 4 feet by 1 foot, dropped from the roof, a height of about 20 feet, fell on a heap of ore 4 feet from the track and rolled towards the car striking the victim on the head, fracturing his skull and causing a comminuted fracture of the right leg. He died about half-an-hour after the accident.

According to the evidence of the foreman in charge, a blast in the wall near the floor had been fired the previous day.

VERDICT:—Accidental death without blame to anybody.

MINES QUARRIES AND MILLS—PROVINCE OF QUEBEC

NON-FATAL ACCIDENTS, 1915

Nos.	Date	Mine or Quarry	Name of Operator	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
1	Jan. 13	Union Mine	Black Lake Asbestos & Chrome Co. Limited.	Y. Charkauxy	18	Labourer	Foot injured	Right foot crushed by falling stone.
2	Jan. 13	Eustis Mine	Eustis Mining Co.	Leon Wyd	30	Trammer	Muscles of shoulder injured.	Stepped into chute he was discharging car into.
3	Jan. 13	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Robert Williams	21	Brakeman	Sprain and contusion of left knee.	While jumping from narrow gauge locomotive he fell to the ground with great force.
4	Jan. 22	Union Mine	Black Lake Asbestos & Chrome Co. Limited.	J. Petroszuk	22	Labourer	Foot injured	Left foot crushed by cable-derrick box.
5	Jan. 23	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Antonio Paradis	24	Brakeman	Contusions lumber region right side.	Car slipped from track and threw injured down and he was caught between the beams of two cars.
6	Jan. 26	Bell Mine	Bell Asbestos Mines	B. Landry	44	Pit labourer	Contusion of lower right limb and right ankle.	Stones rolled over him.
7	Jan. 28	Bell Mine	Bell Asbestos Mines	Thomas Suite	45	Pit labourer	Left wrist bruised	Was holding a wedge, when another man striking it with hammer missed it and struck his wrist.
8	Jan. 28	St. Marc Quarry	La Compagnie des Carrieres de St. Marc	Hubert Arnault	45	Stone cutter	Eye injured	Struck in the eye by a flying chip of stone.
9	Jan. 29	Deschambault Quarry.	The Deschambault Stone Co. Limited.	Jos. Martel	33	Stone cutter	Blood poisoning	Caused by a rusty nail.
10	Feb. 5	Kings' Mine	Asbestos Corporation of Canada Limited.	Pierre Roy	20	Pit labourer	Right eye injured	While breaking a stone with a hammer a little stone flew in his eye.
11	Feb. 8	Eustis Mine	Eustis Mining Co.	George Daignault	19	Dresser	Back bruised	Was playing around the chute at the mill and jumped over the side and fell on his back.
12	Feb. 9	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Zephirin Poirier	50	Labourer	Contused wound index finger right hand.	Box descended and struck injured, knocking him down.

13	Feb.	26	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Ivan Basatsky	35	Labourer	Punctured wound of right forearm.	Piece of rock rolled down from pile and struck injured.
14	Feb.	27	Bell Mine	Bell Asbestos Mines	P. Paquet	28	Brakeman	Left hand sprained	While dumping a car of sand injured was holding the brake wheel and it gave such a jerk that it sprained his hand.
15	Feb.	27	Martin-Bennett	The Martin-Bennett Asbestos Mines Limited.	Wilfred Boucher	28	Labourer	Strained back	Fell while carrying part of a drill.
16	March	1	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Simeon Belair	41	Labourer	Contused right side of pelvis with fracture of ribs.	Cable derrick box fell down down and struck injured.
17	March	1	Kings' Mine	Asbestos Corporation of Canada Limited.	Leonidas Demers	47	Pit labourer	Left eye badly injured	While breaking rock, a piece of rock struck him in the eye.
18	March	6	Union Mine	Black Lake Asbestos & Chrome Co. Limited.	S. Tarabas	28	Labourer	Big toe left foot injured.	By falling stone.
19	March	16	Union Mine	Black Lake Asbestos & Chrome Co. Limited.	A. Sazoco	26	Labourer	Thigh injured	Rolling stone struck his thigh.
20	March	18	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	John Peddle	34	Hoist engineer	Infection in right hand	Hoisting rope broke and threw injured against the side of the hoisting building.
21	March	20	Lime Quarry	Standard Lime Co. Ltd.	Jos. Lafournaise	25	Labourer	Left leg broken	A slide of rock fell on his leg.
22	March	30	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Vincent Gagnier	30	Labourer	Contusion dorsal surface left hand.	Injured was holding a chisel in the crack of a piece of rock when party swinging the hammer missed the chisel and struck him on the hand.
23	April	5	Beaver Mine	Asbestos Corporation of Canada Limited.	Ernest Giguere	30	Loader	Sprained back	The employee was loading a piece of frozen dirt which slipped from his hands and in trying to get another hold of it he felt a pain in his back.
24	April	7	Bell Mine	Bell Asbestos Mines	F. Lapierre	43	Foreman	Right leg bruised above ankle.	Big stone rolled down and jammed his leg against the derrick box.
25	April	8	Johnson's Mine	Johnsons' Co.	Joseph Carrier	30	Labourer	Had left foot bruised	By being jammed between two stones at which he was working.
26	April	10	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Arthur Haince	19	Bagger	Sprain of left knee	Slipped on mud caused by frost and fell.
27	April	10	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	James Stewart	55	Labourer	Contused wound upper thigh left leg and sprained left knee.	Large piece of rock rolled down from pile and threw him down.

NON-FATAL ACCIDENTS, 1915.—Continued

Nos.	Date	Mine or Quarry	Name of Operator	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
28	April 12	Union Mine	Black Lake Asbestos & Chrome Co. Limited.	J. Krecuk	39	Labourer	Finger crushed and finally amputated.	Index finger left hand, crushed between two rocks.
29	April 15	Bell Mine	Bell Asbestos Mines	Scofoni Lotovico	25	Pit labourer	Right collar bone broken, two or three ribs broken and top part of head cut.	Was struck by cable-derrick box which was being lowered in the pit.
30	April 15	Bell Mine	Bell Asbestos Mines	A. Letourneau	18	Pit labourer	Left big toe bruised	By big stone rolling down from side of pit.
31	April 15	Bell Mine	Bell Asbestos Nines	Israel Bilodeau	49	Carpenter	Fracture of a bone of right small finger.	His right hand was caught between belt and pulley in mill.
32	April 17	Bell Mine	Bell Asbestos Mines	J. B. Huard	32	Dump man	Left big toe bruised	Got his toe caught between car leg and car frame.
33	April 19	Johnsons' Mine	Johnsons' Co	Albert Leheux	20	Pit labourer	Wound to right hand	Falling on a sharp piece of rock.
34	April 19	Kings' Mine	Asbestos Corporation of Canada Limited.	Narcisse Cantin	58	Labourer	Sprained back	In lifting a stone.
35	April 20	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Joseph Tellier	56	Labourer	Deep contused wound palmar surface left hand.	One of the rollers, which runs a belt, got clogged with piece of rock and injured, with a piece of wood, tried to release same when the roller twisted stick with such force and caused above accident.
36	April 22	Union Mine	Black Lake Asbestos & Chrome Co. Limited.	Y. Charkauy	18	Labourer	Foot and wrist injured	Rolling stone struck foot and wrist.
37	April 27	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Narcisse Jutras	43	Millwright	Contusion and fracture of right big toe.	Piece of steel slipped from injured's hand.
38	April 29	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Odilon Baudreau	58	Labourer	Injury of upper part of thorax and fracture of three ribs right.	Crushed between car and stand.
39	April 30	Union Mine	Black Lake Asbestos & Chrome Co. Limited.	S. Tarabas	28	Labourer	Finger broken	Left middle finger, compound fracture, crushed between rock.
40	May 6	Eustis Mine	Eustis Mining Co	Henry Humphrey	21	Labourer	Little finger of right hand cut off at first joint.	While handling a tie he stumbled and put his hand on another tie just as a fellow workman drove his axe into it.

41	May	7	British Canadian...	Asbestos Corporation of Canada Limited.	Gaudias Noel.....	34	Oiler.....	Left arm at elbow twisted or sprained.....	While oiling some machinery his shirt got caught in a shaft.
42	May	7	British Canadian...	Asbestos Corporation o Canada Limited.	Mike Okuloski.....	22	Labourer.....	Serious contusion of the muscles of the abdomen and lumber muscles.	Okuloski was on a car dumping a cable-derrick box when another box came along and caught him between the two.
43	May	7	Jeffrey Mine.....	The Asbestos & Asbestic Co. Limited.	Benjamin Ploude...	54	Labourer.....	Contused wounds, left ear and over right molar bone.	While cleaning out under the revolving screens struck his head against, the bolts.
44	May	11	British Canadian...	Asbestos Corporation of Canada Limited.	Peter Chakalook...	22	Labourer.....	Had his right big toe mashed, causing the nail to fall off.	Trying to take a chain from under a rock, the rock turned over catching his right foot.
45	May	12	Beaver Mine.....	Asbestos Corporation of Canada Limited.	Henri Gravel.....	29	Labourer.....	Sprained shoulder and back.	Piling bags of asbestos in storage shed one of the piles topped over.
46	May	14	Jeffrey Mine.....	The Asbestos & Asbestic Co. Limited.	J. Wierzlicki.....	26	Labourer.....	Fracture metacarpal bone right great toe and foot badly.	Large piece of rock rolled down from pile.
47	May	18	Johnsons' Mine....	Johnsons' Co.....	Kondrat Kowalczuk	45	Labourer.....	Bruises on both legs and right shoulder, cut in head.	Knocked down by small car which was being backed down a track.
48	May	20	Jeffrey Mine.....	The Asbestos & Asbestic Co. Limited.	Pierre Laucette....	18	Bagger.....	Amputation of three fingers, right hand.	Allowed fingers to get into bagging machine.
49	May	24	Bell Mine.....	Bell Asbestos Mines....	Pierre Ploude.....	39	Carpenter.....	Tip of right thumb badly bruised.	While moving a long slide he had his thumb caught between the slide and the building.
50	May	31	Tetrault Mine.....	Weedon Mining Co. Limited.	Lewis Kenty.....	20	Machine runner....	Face badly burned, numerous scalp wounds.	Drilled into missel hole.
51	June	1	Kings' Mine.....	Asbestos Corporation of Canada Limited.	Ronald Desruisseaux	21	Sweeper.....	Right third finger injured.	The broom was caught in a pulley.
52	June	3	British Canadian...	Asbestos Corporation of Canada Limited.	E. Gadbout.....	41	Labourer.....	Both wrist and knee bruised.	Row of asbestos bags topped over throwing this man to the side of truck.
53	June	5	Bell Mine.....	Bell Asbestos Mines....	David Moore.....	36	Pit Labourer.....	Right index finger bruised	Injured had his right hand caught between a stone side of box.
54	June	8	B. & A. Mine.....	B. & A. Asbestos Co....	.Ivan Arshewski...		.....	Inflammation in the ball of the eye.	Breaking rock with a sledge, when a piece of stone struck him in the eye.
55	June	8	B. & A. Mine.....	B. & A. Asbestos Co....	Napoleon Dulac....	18	Oiler.....	Arm fractured, ribs broken, shoulder injured.	In repairing a belt conveyor.
56	June	8	Union Mine.....	Black Lake Asbestos and Chrome Co. Limited.	J. Krecuk.....	39	Labourer.....	Right knee cut.....	By falling stone.

NON-FATAL ACCIDENTS, 1915.—Continued

Nos.	Date	Mine or Quarry	Name of Operator	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
57	June 11	King's Mine	Asbestos Corporation of Canada Limited.	Simeon Octeau	18	Labourer	Left foot bruised	A stone rolled from a jam and hit his foot.
58	June 14	King's Mine	Asbestos Corporation of Canada Limited.	Achelle Richard	17	Labourer	Left foot bruised	A stone rolled from a jam and hit his foot.
59	June 14	Maisonneuve Quarry	Joseph Rheaume	Pierre Trudel	40	Quarryman	Right leg injured	Between two stones which rolled down.
60	June 16	Johnson's Mine	Johnsons' Co	Philippe Gagnon	22	Pitman	Left knee injured	Stone working loose from a pile.
61	June 17	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Napoleon Legendre	40	Labourer	Severe compound fracture index finger, left hand.	Piece of rock rolled down slip, injured's finger being crushed between pieces of rock.
62	June 24	B. & A. Mine	B. & A. Asbestos Co.	Alfred Marceau	31	Blacksmith	Tip of index finger crushed, tip of major finger cut.	In a buzz planer.
63	July 1	King's Mine	Asbestos Corporation of Canada Limited.	Desire Richard	23	Labourer	Small wound on the head.	Small piece of rock fell from side of pit.
64	July 5	Bell Mine	Bell Asbestos Mines	Damase Gauthier	41	Drill helper	Second and third finger of right hand bruised.	While moving drill he fell.
65	July 7	Jacobs Mine	Jacobs Asbestos Mining Co.	M. Kostanuk	21	Pit labourer	Left knee bruised	A pit box struck him on the knee.
66	July 8	Bell Mine	Bell Asbestos Mines	Francois Couture	62	Pit labourer	Right eye injured	While breaking stone, a small piece of rock flew to his eye.
67	July 10	King's Mine	Asbestos Corporation of Canada Limited.	Alfred Cote	23	Labourer	Two cuts on the head and several bruises on the body.	While removing some loose, a rock rolled from the side of the pit.
68	July 12	British Canadian	Asbestos Corporation of Canada Limited.	Ed. Henri	25	Labourer	Left arm bruised	In oiling a cable-derrick carriage he had his left arm caught between rope and sheave.
69	July 13	East End Quarry	E. W. Villeneuve	Carmine d'Apice	42		Loss of one eye	While breaking stone.
70	July 13	Jeffrey Mines	The Asbestos & Asbestic Co. Limited	Hermas Larose	19	Labourer	Severe contusion and sprain of right ankle.	Rope slipped from rock and caught injured by the right leg.
71	July 14	British Canadian	Asbestos Corporation of Canada Limited.	M. Gashman	32	Labourer	Right ankle sprained	He was slacking a stone in a car and had his right ankle caught.

72	July	14	Bell Mine	Bell Asbestos Mines	David Therrien	44	Carpenter	Left thigh bruised	While doing some repair between two cars the locomotive butted the cars, and he was caught between draw bars.
73	July	15	British Canadian	Asbestos Corporation of Canada Limited.	Theodore Casaric-huck.	42	Labourer	Cut on left side of head front of ear.	Struck by stone falling from side of pit.
74	July	19	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Theodor Milluk	34	Labourer	Contused wound left great toe.	While repairing narrow-gauge track rail fell off his foot.
75	July	21	Union Mine	Black Lake Asbestos and Chrome Co. Limited.	A. Lacroix	39	Teamster	Foot injured	Right foot bruised by falling stone.
76	July	27	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Alphonse Girouard	37	Labourer	Severe contused wound right hand.	Hand crushed between box and rock.
77	July	28	Jacobs Mine	Jacobs Asbestos Mining Co.	M. Mathieu	18	Pit labourer	Broken leg	Fell down pit stairs.
78	July	29	Kings' Mine	Asbestos Corporation of Canada Limited.	Ludger Couture	34	Cobbing contractor	Fractured rib	Was struck in the ribs by the chain of a cable-derrick box.
79	July	29	Pit No. 2	The Martin-Bennett Asbestos Mines Limited.	Henry Huot	19	Pit labourer	Right foot crushed	By end of mine box coming down on it.
80	July	29	Granite Quarry	The Laurentian Granite Company Limited.	Fortunat Girard	34	Quarry man	Fractured ribs	Slipped and fell down on a pile of stone.
81	July	30	Rosemont Quarry	O. Martineaux Fils Ltee.	Fred. Belisle	29	Driller	Bruns and fracture of left leg.	Prematured blast.
82	July	30	Rosemont Quarry	O. Martineaux Fils Ltee.	Eliano Homanuck	40	Labourer	Burns and fracture of skull.	Prematured blast.
83	July	31	Union Mine	Black Lake Asbestos and Chrome Co. Limited.	P. Hartysk	28	Labourer	Finger crushed	Right index crushed by stone.
84	Aug.	2	Lime Ridge Quarry	The Dominion Lime Co.	Joseph Cote	..		Shoulder fractured and bruised hip.	Fell from stand while cleaning out gas pipe.
85	Aug.	4	Clay Pit	La Compagnie de Briques de Quebec Limitee.	C. A. Labelle	38	Labourer	Right foot crushed	By side dumping car.
86	Aug.	4	King's Mine	Asbestos Corporation of Canada Limited.	Esdras Gregoire	19	Labourer	Right knee bruised	Caught between dumping box and a piece of rock which rolled from jam.
87	Aug.	9	B. & A. Mine	B. & A. Asbestos Co.	Sergey Harris	35	Miner	Two bones broken right hand.	Rock rolling down from pile hit his right hand.
88	Aug.	10	Union Mine	Black Lake Asbestos & Chrome Co. Limited.	O. Rudiak	30	Labourer	Foot injured	Falling stone bruised left foot.
89	Aug.	16	Standard Quarry	Standard Lime Co. Limited.	P. Brault	40	Labourer	Seven ribs broken	Buried under the load of a car.
90	Aug.	16	Union Mine	Black Lake Asbestos & Chrome Co. Limited.	P. Waytuk	22	Labourer	Big toe bruised	Rock rolling down pile.
91	Aug.	18	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Joseph Lambert	18	Labourer	Severe contused wound right thumb.	Caught his thumb in the pinion of a winch.
92	Aug.	19	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	John Purcell	18	Bagger	Contused wound third finger right hand.	Injured's finger caught under one of the wheels of the rack of a bagging machine.

Nos.	Date	Mine or Quarry	Name of Operator	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
93	Aug. 20	B. & A. Mine	B. & A. Asbestos Co.	K. Semenyink	43	Miner	Scratched bones and contusions on the legs.	A swinging cable-derrick box struck him on both legs.
94	Aug. 26	Johnsons' Mine	Johnsons' Co.	Joseph Mercier	58	Labourer	Inflammation in the right eye.	Struck in the eye by a small stone.
95	Aug. 27	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Alphonse Poirier	23	Tinsmith	Punctured wound of right foot.	Tramped on nail which went through his boot.
96	Aug. 31	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Amedee Leblanc	14	Bagger	Contused wound right hand and forearm.	Knocked down by truck.
97	Sept. 1	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Peter Kowal	22	Labourer	Contused wound left hand.	Piece of rock rolled down and struck his hand.
98	Sept. 1	Union Mine	Black Lake Asbestos & Chrome Co. Limited.	J. Lemicnych	20	Labourer	Hip bruised	Slipped and fell on his way to work.
99	Sept. 2	Johnsons' Mine	Johnsons' Co	Lewis Langlois	58	Labourer	Bruised left foot	A stone rolled over on his foot, bruising same.
100	Sept. 4	Kings' Mine	Asbestos Corporation of Canada Limited.	Ernest Gilbert	18	Loader	A cut on the right thumb	A hoisting chain in motion struck Gilbert's thumb.
101	Sept. 4	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Urbain Girouard	33	Driller	Contused wound left hand.	Fingers caught between two pieces of rock.
102	Sept. 6	Jacobs' Mine	Jacobs Asbestos Mining Co.	O. Bertrand	20	Pit Labourer	Back of left hand bruised.	A stone fell on his hand.
103	Sept. 7	Jacobs' Mine	Jacobs Asbestos Mining Co.	A. Mihachan	51	Pit Labourer	Cut of five inches below left knee.	A stone fell on his leg.
104	Sept. 7	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Jos. Aubie	39	Labourer	Severe sprain of lumbar muscles.	While lifting a piece of rock the injured slipped and fell.
105	Sept. 8	Bell Mine	Bell Asbestos Mines	Albert Jacob	39	Pit Labourer	Right ankle slightly bruised.	When lifting a big stone a piece broke off and fell on his foot.
106	Sept. 10	Johnsons' Mine	Johnsons' Co	George Penny	30	Fireman	Scalded left foot	Slipped from stool into small pool of hot water from heater exhaust.
107	Sept. 11	Johnsons' Mine	Johnsons' Co	Theodule Gilbert	50	Labourer	Serious bruise of left third finger.	Coupling cars.
108	Sept. 13	Jacobs' Mine	Jacobs Asbestos Mining Co.	K. Litwak	53	Pit Labourer	Right knee cut	A pit box struck him, knocking him against stone.
109	Sept. 14	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Hormidas Garneau	58	Labourer	Contused wound left hand.	Piece of rock fell on injured's hand.

110	Sept.	16	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Narcisse Desmarais.	51	Labourer	Contused wound right hand.	While patching a hole in a spout he slipped and fell.
111	Sept.	17	Beaver Mine	Asbestos Corporation of Canada Limited.	Emil Smook	33	Labourer	Left ankle crushed	Caught between two boxes.
112	Sept.	21	Eustis Mine	Eustis Mining Co	Felix Jacques	45	Driller	Injury to left shoulder	Was standing on drill tripod when it slipped and he fell off twelve-foot wall.
113	Sept.	25	No. 1 Pit	The Martin-Bennett Asbestos Mines Limited.	Jean Hebert	32	Labourer	Cut about face	Mine car coming out of tunnel pushed him off edge into bottom of pit twelve feet below.
114	Sept.	25	No. 1 Pit	The Martin-Bennett Asbestos Mines Limited.	Jim Babin	35	Driller	Cut about face and head	While drilling, car coming from tunnel knocked him over edge into pit twelve feet below.
115	Sept.	27	King's Mine	Asbestos Corporation of Canada Limited.	Antoine Bellemare	59	Labourer	Right foot bruised	Struck by a piece of rock which fell from box.
116	Sept.	29	Nault Quarry	La Cie des Carrières de St. Marc.	Patrick Trottier	22	Labourer	Loss of one eye, seriousiy wounded the other eye, all over face, on the hands and stomach	In unloading a hole which had not exploded.
117	Oct.	4	Johnsons' Mine	Johnsons' Co	Wasil Lesseski	50	Labourer	Flesh wound on the head	By a chain attached to one corner of cable-derrick box which slipped and struck him.
118	Oct.	4	Jeffrey Mine	The Asbestic & Asbestic Co. Limited.	Aime Bourassa	20	Labourer	Right thumb burst open	Injured's thumb caught between wheel of cable-carriage and hoisting rope.
119	Oct.	5	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Ford Courtemanche	38	Teamster	Contused wound left hand.	While unloading a casting it slipped and crushed his hand.
120	Oct.	9	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Joseph Marcotte	32	Labourer	Contused wound right leg	Large piece of rock rolled down from pile.
121	Oct.	18	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Unat Boruk	40	Labourer	Contused wound left hand.	Piece of rock rolled down on injured's hand.
122	Oct.	18	Union Mine	Black Lake Asbestos & Chrome Co. Limited.	T. Harris	24	Labourer	Finger crushed	Second right finger crushed by stone.
123	Oct.	18	Kings' Mine	Asbestos Corporation of Canada Limited.	Napoleon Boisvert	31	Labourer	A piece of asbestos fibre driven into thumb.	While lifting a piece of rock to place it in hoisting box the rock slipped and piece of crude vein stuck in his thumb.
124	Oct.	22	Johnsons' Mine	Johnsons' Co	Denis Byrus	40	Labourer	Ankle of left foot bruised and sprained.	Small car jumping track, catching the man between locomotive and draw bar of car.
125	Oct.	25	B. & A. Mine	B. & A. Asbestos Co	Jean Jacques	52	Miner	Fore arm broken	Struck by rolling stone.

Nos.	Date	Mine or Quarry	Name of Operator	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
126	Oct. 27	Beaver Mine	Asbestos Corporation of Canada Limited.	Gedeon Leblond	52	Labourer	Small toe left foot broken	A piece of rock fell on it while loading boxes.
127	Oct. 27	Plant No. 1	Canada Cement Co. Limited.	Raffele Martello	51	Switchman	Knee badly bruised and face scratched.	Stepped on wrong side of quarry car and was knocked down by cable.
128	Oct. 30	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Aime Vincent	28	Derrick repair man.	Contusion of right big toe.	Clamp fell from bench on injured's toe.
129	Nov. 2	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Hormidas Garneau	58	Labourer	Contused lacerated wound right leg.	Piece of rock rolled down on injured's leg.
130	Nov. 3	Kaolin Pit	Canadian China Clay Co. Limited.	Louis Trudel	22	Labourer	Leg broken	A lump of earth from side wall, gave way and rolled down. In trying to avoid it, he tripped over, and was struck on the leg by it.
131	Nov. 5	Kings' Mine	Asbestos Corporation of Canada Limited.	Achille Landry	48	Labourer	Middle finger right hand bruised.	A piece of pipe fell on his fingers.
132	Nov. 6	Beaver	Asbestos Corporation of Canada Limited.	Onésime Lafond	53	Labourer	Bruise of the two first toes of right foot.	While placing a piece of rock in hoisting box it slipped from his hands and fell on his foot.
133	Nov. 8	Kings' Mine	Asbestos Corporation of Canada Limited.	Joseph Vachon	50	Labourer	Contusion of the left arm and contusion and erasion of the left thigh.	Struck by a stone which rolled from a jam.
134	Nov. 9	Kings' Mine	Asbestos Corporation of Canada Limited.	Petro Skawarcyuk	60	Labourer	Contusion of both knees with sprain of the knee joints.	Struck by a piece of rock which rolled from a pile.
135	Nov. 9	Kings' Mine	Asbestos Corporation of Canada Limited.	Samuel Lamothe	39	Cobbing Contractor	Left foot bruised and one of small bones broken.	He was endeavoring to move a rock with a crowbar and while at this work he accidently hit his foot with the crowbar.
136	Nov. 12	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Miron Bojczuk	42	Labourer	Contused wound right leg middle third	Piece of rock rolled down from pile on injured's leg.
137	Nov. 18	Kings' Mine	Asbestos Corporation of Canada Limited.	Louis Turcotte	40	Labourer	Bruised hand	Turcotte was tightening with a wrench, when it slipped and he struck the back of his right hand against a piece of iron.

138	Nov.	19	Granite Quarry	James Brodie	Alex. Munroe	26	Labourer	Injury to legs	Chain broke and wound around victim's legs.
139	Nov.	21	Jacobs' Mine	Jacobs Asbestos Mining Co. Limited.	Henri Vallee	18	Pit Labourer	Both knees cut and bruised.	A stone fell on his knees.
140	Nov.	22	Jacobs' Mine	Jacobs Asbestos Mining Co. Limited.	S. Gavriluk	59	Pit Labourer	Rupture	Struck by a pit box.
141	Nov.	24	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Albert Lemay	34	Labourer	Contusion of right side	While applying brake to a car injured was caught between the car and the dumping stand.
142	Nov.	25	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Joseph Croat	35	Labourer	Fracture of rib	While repairing a cable-way carriage he slipped and fell on the wheel.
143	Nov.	26	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Harry Stewart	46	Foreman	Injuries to the head and contusion of the neck and legs.	Hoisting box struck injured on the head knocking him down one of the steps a distance of about 40 feet.
144	Dec.	3	Breeches Lake Workings.	R. L. Stewart-Patterson.	Edward Goulet	48	Contractor	Back of head bruised and nose injured.	Fall of rock at entrance of drift.
145	Dec.	3	Bell Mine	Bell Asbestos Mines	Léon Bergeron	21	Car loader	Right knee dislocated	Injured got buried up with bags of fibre.
146	Dec.	4	B. & A. Mine	B. & A. Asbestos Co.	Sewell Prosetti	25	Miner	Sprained ankle	While picking up tools he got hit by box coming down.
147	Dec.	6	Kings' Mine	Asbestos Corporation of Canada Limited.	Joseph Nadeau	18	Labourer	Right hand bruised	Victim was at work breaking rock when he accidently struck his hand with the hammer.
148	Dec.	6	Beaver Mine	Asbestos Corporation of Canada Limited.	Ed. Carrier	21	Labourer	Two middle fingers of right hand burnt.	Carrier had safety matches in his right hand when he started lighting. These caught fire and burnt his fingers.
149	Dec.	7	Jeffrey Mine	The Asbestos & Asbestic Co. Limited.	Sidney Bristow	31	Labourer	Contused wound of right knee.	While lifting a piece of rock it fell and struck inujred's knee.
150	Dec.	10	Kings' Mine	Asbestos Corporation of Canada Limited.	Achille Chamberland	24	Labourer	Right leg bruised	Chamberland was standing on the platform of a car. He slipped and his leg was caught between the couplings of the car.
151	Dec.	11	British Canadian	Asbestos Corporation of Canada Limited.	Eustache Jean	63	Labourer	Cut and bruise on right leg.	A piece of rock struck his right leg by causing a cut and bruise to same.
152	Dec.	13	Bell Mine	Bell Asbestos Mines	Omer Ouellet	23	Pit Labourer	Big toe of right foot bruised.	Injured was lifting a big stone when it slipped out of his hands and dropped on his big toe.

Nos.	Date	Mine or Quarry	Name of Operator	Name of Injured	Age	Occupation	Nature of Injury	Cause of Accident
153	Dec. 18	Kings' Mine.....	Asbestos Corporation of Canada Limited.	Delphis Drouin....	25	Labourer.....	Right eye injured.....	Drouin was breaking rock with a hammer, when a small piece struck him in the eye, causing an inflammation.
154	Dec. 18	Kings' Mine.....	Asbestos Corporation of Canada Limited.	Louis Goulet.....	40	Labourer.....	Sprained back.....	While lifting a wheel.
155	Dec. 20	Kings' Mine.....	Asbestos Corporation of Canada Limited.	Alphonse Labbe....	25	Labourer.....	Third and fourth fingers of right hand bruised and cut.	While loading rock into cable-derrick box a piece slipped on his fingers cutting and bruising them.
156	Dec. 20	Jacobs' Mine.....	Jacobs Asbestos Mining Co.	Geo. Thomas.....	22	Pit Labourer	Four toes on left foot broken.	A heavy rock fell on his toes.
157	Dec. 21	Beaver Mine.....	Asbestos Corporation of Canada Limited.	Alphege Provost...	26	Driller.....	Right hand burnt.....	Provost had five safety fuses in his right hand when he started lighting. These caught fire and burnt his right hand.
158	Dec. 22	Beaver Mine.....	Asbestos Corporation of Canada Limited.	Ivonistzki Pantelenon.	28	Labourer.....	Right ankle sprained....	He slipped on a stone.
159	Dec. 28	Beaver Mine.....	Asbestos Corporation of Canada Limited.	Alex. Morin.....	60	Labourer.....	Left wrist sprained.....	Slipped on ice and in trying to protect himself from a fall, sprained his wrist.
160	Dec. 29	Jeffrey Mine.....	The Asbestos & Asbestic Co. Limited.	Tiercuk Samogt....	26	Labourer.....	Contusion index finger right hand.	Rock slipped from the fingers of another man crushing injured's finger against the side of a box.

STORING OF EXPLOSIVES.

Some mines or quarries, where hundreds of tons of ore or rock are broken daily, have, for economical reasons and in order to cope with their large daily consumption, adopted the custom of buying explosives by the carload. From the moment these are received at the mine until the time they are to be used, they must be properly stored. According to the regulations ordered under the authority of article 2214 of the R.S.P.Q., 1909, it is enacted "that the storing of explosives shall be made in magazines or powder-houses, built to the satisfaction of the Inspector of Mines. Such magazines shall not be built nearer than 400 feet from the mine or works, or from any public highway, without a special authorization from the Inspector of Mines."

Explosives are used for their special properties; in order to keep these as efficient as possible, also to make the handling of dynamite and powder safe, special precautions must be taken in the construction of the magazine in which they are to be stored or kept. It is essential that magazines be protected against theft, fire, water and bullets, and possibly against lightning. A good lock will keep the burglars away; incombustible material will safeguard against fire; a good roof, proper location and good ventilation will protect explosives from humidity and preserve them from coming into contact with water; a thickness of the proper material may render the building bullet-proof. As to protection against lightning, there is no real efficient system known yet. Nevertheless, some of the European countries have enacted laws requiring all magazines to be provided with lightning conductors. Still, with all the above precautions, a magazine may explode under the influence of unknown causes. Consequently, the building must be constructed in such a way, and of such material, that, in the event of a misfortune, the least possible damage will be done to adjoining dwellings and public roads. This consideration has led to the adoption of a light wooden structure as the most convenient storage house for explosives.

Location:—The damages caused by the explosion of a magazine are made by the missiles projected and by a concussion of the air,

causing a circular air wave, which is perhaps more destructive than the projectiles. The strength of this air wave, at a certain point, is proportionate to the force of the explosion and the distance of this point from the center of explosion.

It is then of the utmost importance, in planning the erection of a building for the safe keeping of explosives, that the distances from occupied buildings and highways should not be overlooked. In order to help the prospective builder, we give the following extract of a table, submitted by Col. B. W. Dunn, chief inspector of the Bureau for the Safe Transportation of Explosives and other dangerous articles, and published in Bulletin 75, Rules and Regulations for Metal Mines, U.S. Bureau of Mines, 1915, which shows distances at which certain quantities of explosives can be stored from nearest buildings, nearest railroad and nearest highway. In the case of a well barricaded magazine, these distances can be reduced by half.

QUANTITY AND DISTANCE TABLE.

Pounds	Distance from nearest building Feet	Distance from nearest railroad Feet	Distance from nearest highway Feet
500	720	430	290
1000	1020	610	400
5000	1500	900	600
10000	1740	1040	700
50000	2680	1610	1070
100000	3580	2150	1430

For the purpose of reducing the destroying action of the air wave, the powder house should be so located as to be out of sight from the point where an explosion is liable to cause damages. Whenever physiographical conditions permit, it should be built in a valley or depression of the ground, so as to afford a natural barricade. It is bad practice to erect such a building on the apron of a hill. A dug out, on account of humidity, is not a suitable place to store explosives.

The protection offered by nature can be improved on by artificial earthworks, such as mounds or barricades. These are usually

built somewhat higher than the highest point of the roof of the magazine, are at least three feet wide on top and have sloping sides. As in the case of an explosion in which the barricade would be too weak to sustain the shock, rubbles and boulders, if present, would be thrown as missiles, it is imperative that these walls consist only of sand and tailings well rammed. Such earthwork will render the magazine quite bullet-proof, as the projectile sent by an ordinary rifle will not go through such thickness. This wall will also be a protection against fire cropping up in the moss or grass during the dry season. A ditch built around an unbarricaded magazine will serve the same purpose.

BUILDING:—A dry, properly located spot, at suitable distance from dwellings and public roads, having been chosen, the next point is with what material should a magazine be built.

Anyone taking the point of view of damages caused by the explosion of dynamite or powder will no doubt advocate a light wooden structure as the proper method of constructing a magazine. But as the prevention is preferable to the cure, we shall, right now, give out a few pointers regarding the prevention of explosions.

Corrugated galvanized iron or asbestos shingles on the outside of a building offers a good protection from the exterior causes of fire. It is good practice to have the walls down to the ground in order to protect the floor. Keeping the ground around the place free from from rubbish, dead grass, shrubbery or other encumbrances, will also eliminate the chances of fire during the summer months.

In late years, different types of storage buildings for explosives have been suggested. Stone, brick, concrete, cement-mortar and sand walls have been advocated. The first three types, though fire-proof and bullet-proof, have been objected to on the ground that if an explosion should occur large pieces of stone, bricks and blocks of concrete would be hurled in the air, and, in their fall, probably cause a lot of mischief.

The United States Bureau of Mines, after a series of experiments, recommends a lean cement mortar as a bullet-proof material, in the proportion of one part of cement to six parts of coarse sand; walls containing a six-inch thickness of such material, and the door and roof, a three-inch thickness. The characteristics of this ma-

terial are resistance to penetration and the ease with which the material will disintegrate when subjected to the force of an explosion. A filling in of fine sand offers poor protection, as it will run between the boards. Coarse tailings well rammed would make a suitable bullet-proof wall. Users of explosives should bear in mind that a bullet fired into a box of dynamite will explode it. A stray projectile, in a country where big game is hunted, or an intentionally fired cartridge, by a criminal, may blow up the storage building and disorganize the mine for a few days, not mentioning the possible damage to properties.

All causes of fire should be eliminated. Magazines must be protected against bush-fires. No uncovered light, such as candles, carbide lamps, torches etc., as well as no smoking should be allowed inside the building. If natural light is not sufficient, only well-insulated electric lights should be resorted to. The electric wires must be enclosed and shall not be within ten feet of the explosives stored. If possible, switches should not be placed in the building.

It is important that a magazine be well ventilated, it should be kept dry and cool, as dampness and heat injure explosives. Dynamite explodes from a shock or a blow at ordinary temperature, and the violence of the shock or blow necessary to explode it diminishes as the temperature increases. Between 350° and 400°, it will explode from heat alone. A very small quantity of dynamite will burn without exploding, but if a large quantity is burned, it is likely to explode. The explosives should be in charge of a man familiar with their safe-keeping. Unauthorized persons should not be allowed near places where explosives are kept. Always keep the door locked. Never delay the repair of a leak in the roof or walls.

Dynamite boxes should be laid flat, right side up, on a sound wood floor free from knots, and so stored that the old stock will be used first. Do not throw the boxes down violently, or slide them along the floor, or over each other, or handle then roughly in any manner. Do not use metal bale hooks in handling the boxes.

All nails in the interior of the building must be counter-sunk. A magazine should be kept dry, clean, free from grit, well ventilated, and all openings for such properly screened. The floor should be swept and kept clean regularly. Sweepings from a dynamite

magazine are destroyed by burning. Sweepings from a powder magazine are done away with by throwing them in water.

No boxes are to be opened in the magazine. Do not have loose dynamite or open boxes in the magazine. Black powder and dynamite should not be kept in the same building. Do not keep blasting caps or electric blasting caps, inflammables, metal tools or other implements in the magazine.

When pursuing development work in small mines and quarries, where only small quantities of explosives are used, there may be no need of a large sized building in which to store them. But, nevertheless, whatever the quantity may be, they should be kept in a special place, in a stout tight fire-proof box, with hinged lids and lock. In constructing these, what has previously been said for a large magazine should be taken into consideration. A warning somewhat like the following should be conspicuously posted about the magazines:

"EXPLOSIVES—MAGAZINE—DANGEROUS."

THAWING EXPLOSIVES.

On the market today, there are different kinds of dynamites, which may be put under three headings: The ordinary dynamite, which crystallizes, or, as commonly said, freezes between 46° F. and 52° F.; the "low-freezing" dynamite or ammonia dynamite, which does not freeze above 35° F.; and another dynamite called non-freezing, which freezes at below 10° F.

Frozen dynamite is less sensitive to shock and consequently becomes less efficient. On the other hand, by vigorous friction, it may explode, and, therefore, is dangerous. In cold weather, dynamite must be thawed before using. This proceeding is not dangerous if done along the lines of approved methods. Accidents are known to have occurred by thawing dynamite improperly.

The thawing must be done slowly and by indirect heat. Dynamite should not be thawed by placing cartridges near a boiler,

steam-pipe, stove, hot-iron plate, hot bricks or stone, near a fire, in hot water, in direct contact with steam, or in exposure to the sun heat. It is hardly necessary to state that it is imprudent to thaw dynamite by body heat, by carrying the cartridges inside of one's boot or inside one's clothes.

Never any more than the amount necessary for one shift should be thawed at the one time. The dynamite will lose its strength if repeatedly thawed and frozen. While being thawed, explosives should be kept in a horizontal position so as to prevent the nitroglycerine segregating at one end of the cartridge and exuding.

Frozen dynamite can be told from thawed dynamite by the rigidness and hardness of the former and the rather soft and plastic appearance of the latter.

Small quantities of dynamite may be thawed by using a water-jacketed vessel. The water used should not be warmer than what can be endured by the wrist. It should never be above 130° F. A cover should be provided for the thawer. Do not put the cartridges in the water. Fig. VI shows thawers sold by explosives companies. Warm water will give off a certain amount of water vapor which is injurious to dynamite, especially ammonia dynamite. When carrying the thawed dynamite to the place where it is to be used, take care to have it well wrapped in heavy cloth and better have a convenient pail as shown in Fig. VII.

When more than a few sticks are needed, they may be thawed in a manure thawing-box. A tight box large enough to receive 200 lbs. of explosives is surrounded by some eighteen inches of fresh manure. This is a cheap but slow process. The cartridges should not be placed directly in the manure piles, as dynamite may absorb moisture, and, in the event of fermentation, may develop an unsafe temperature.

Low Pressure Steam Heat.—The safest means of thawing explosives is by low pressure steam, which is usually available from the exhaust of the engine room. This pressure should not exceed three pounds to the square inch. Every mine or quarry thawing explosives should be provided with a separate place for that purpose on the surface, or with a special underground chamber, such as a part of an unused drift or cross-cut.

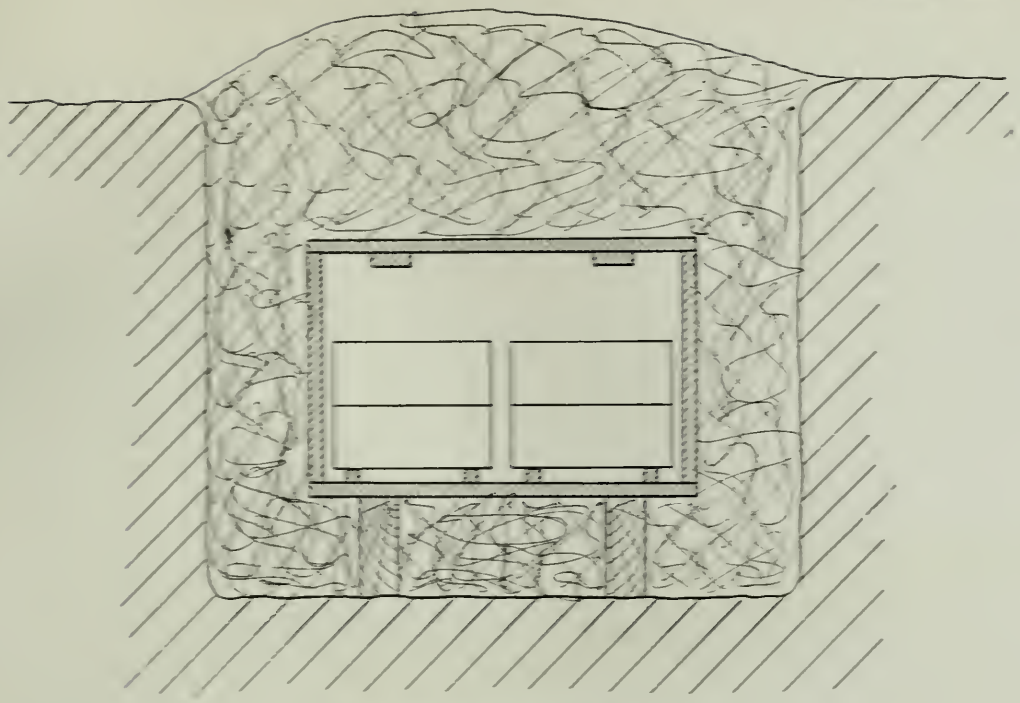
PLATE VI.

Thawing Kettle.

PLATE VII.

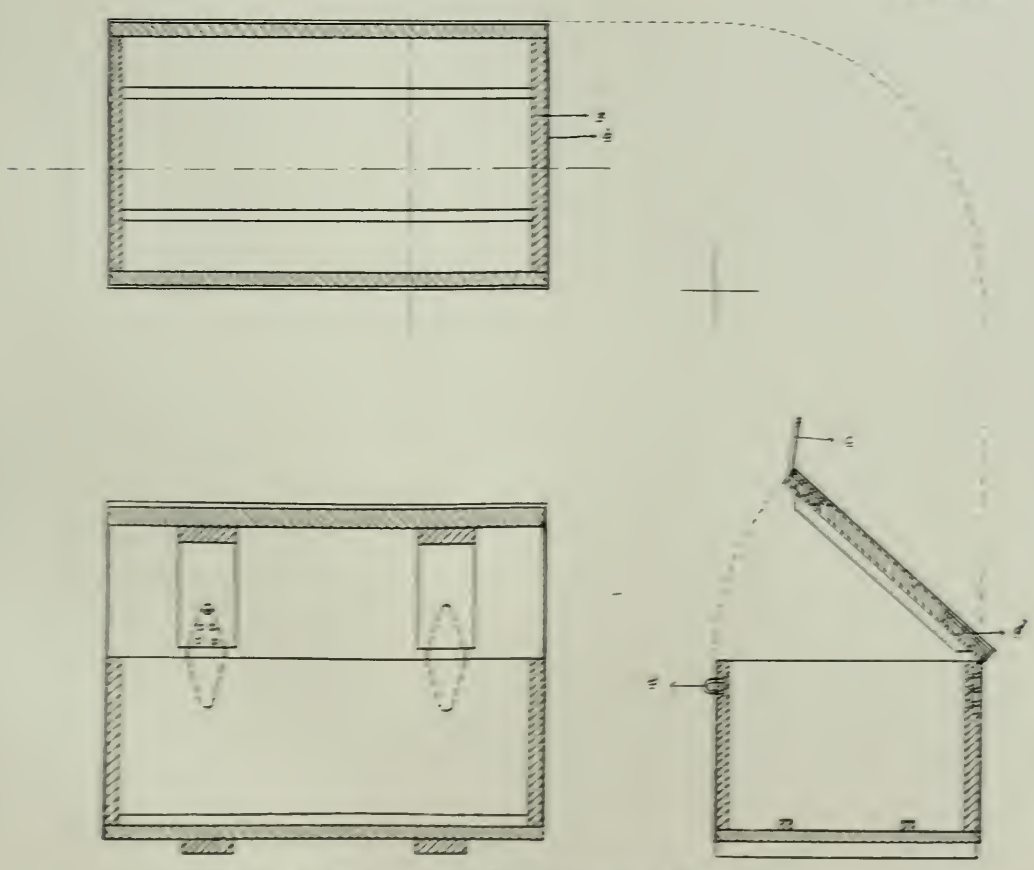
Thawing Kettle.

PLATE VIII.



Thawing explosives by manure

PLATE IX.



Chest for keeping small quantities of explosives.

(a) 1½-inch board; (b) asbestos shingles or corrugated galvanized iron sheets; (c) hasp; (d) hinges; (e) staple.

Thaw House

(a) anteroom; (b) shelves; (c) steam or hot water coils; (d) window; (e) asbestos shingles.

BUILDING:—A thaw-house situated at a suitable distance from dwellings and public roads, well protected from burglars, cold, fire, water and bullets, should be built not less than one hundred feet from the powder-house. What has been said as to the construction of the powder-house applies to the building of a thaw-house. Besides being well protected from the cold, it must be well ventilated. The ventilators should have trap-doors to regulate the draft. A recording thermometer should be placed inside the thaw-house, and the man in charge should see that the temperature is kept uniform.

The cartridges should be laid flat on shelves, and the heater so placed that no dynamite can accidentally fall on it. If dynamite is exposed for a long time to a temperature of 90° or higher, it becomes more sensitive to shock and may lose strength by exudation. In some thaw-houses, the steam coils are placed at one end of the building, in others, in the center with the shelves on the walls, in others again along the walls while the shelves are in the center. The United States Bureau of Mines has advocated the construction of an extension in which the steam pipes shall be placed. The racks must be placed some distance away from the heating pipes. The building should have an ante-room opening into the room where explosives are thawed, to guard this room against any sudden change in temperature. The racks must be thoroughly cleaned and washed at least once a month.

No caps and fuses should be kept in the thaw-house. Fuses should be kept in a cold place.

HOT WATER HEAT:—The low-pressure steam coils of the previous type of thaw-houses, have been replaced at certain mines by hot-water coils. The same precautions which have been advocated for the steam type of thaw-house must be taken with the hot-water type. The water-heater, stove, furnace, etc., must not be nearer than twelve feet from the building in which the explosives are being thawed, and should be well protected from fire. It is claimed that this system has the advantage, over the low-pressure steam method of giving a much more uniform heat.

HOT-AIR HEAT:—Some thaw-houses are heated by hot-air circulation. As for hot-water heat, the stove warming the air, and thus creating the circulation, must be situated at a distance not

less than 12 feet from the thaw-house. This system which has the advantage of being cheap is not to be recommended, since as for hot-water heat, the source of heat is too near the thaw-house. It is difficult to regulate the heat. The conduit of hot-air may at a certain moment, if a defect in the chimney occurs, give passage to the smoke and gases, and perhaps also flames, from the stove, which could create quite a nuisance in the thaw-house, and perhaps be the cause of an explosion. As a general rule, wood-burning stoves or furnaces should not be erected near thaw-houses, as they often give out sparks during a strong wind, which might set fire to the surrounding buildings.

A better method of warming the air used for thawing explosives is by the use of an electric heater, either of the electric resistance or cluster lamps types. These two methods have been employed with success especially in underground thawing rooms. Again, the above rule given for the previous types of heater is to be applied. The electric heater must be placed at a distance of at least 12 feet from the explosives, in a special fire-proof box, room or building.

It must be remembered that electric heaters are less efficient and less safe than low pressure steam. Sparks and flashes may be produced, which are sufficient to ignite a fire and cause an explosion. It is also very difficult to regulate the temperature.

Of all these methods the low pressure steam heat is by far the safest.

The extra expense of constructing a pipe line to take in the steam from the exhaust of the engine room will always be warranted by the satisfaction obtained and the safety secured in thawing the explosives.

Underground Thaw-house:—No more than a twenty-four hour supply must be taken down into a mine. The thawing-room must be located in an out of the way drift, in such a way that an accidental explosion would not cut off the escape of the men working in the mine.

A very serious danger in an underground magazine and thaw-house is lightning, which may cause the explosion of the dynamite stored therein. Cases such as this are known to have happened.

Tétreault's Concentrating Mill, on lot 40, range I, S.W., Montauban township.

THE GEOLOGY OF PARTS OF THE TOWNSHIPS OF MONTAUBAN AND CHAVIGNY AND OF THE SEIGNIORY OF GRONDINES.

INCLUDING A DESCRIPTION OF THE ZINC AND LEAD DEPOSITS IN THE VICINITY OF NOTRE DAME DES ANGES, PORTNEUF COUNTY.

By J. Austen Bancroft.

INTRODUCTION

At Batiscan, about twenty miles below Three Rivers, the Batiscan river enters the St. Lawrence river from the north. On the banks of this tributary and forty-two miles from its mouth, the little village of Notre Dame des Anges is situated in Portneuf County, and on the Canadian Northern railway, 125 miles north of Montreal. In a straight line, this village is 51 miles slightly north of west of the city of Quebec, from which by the C. N. R., via Garneau Junction, it is 106 miles distant, or via Rivière à Pierre Junction, 68 miles.

In the autumn of 1910, Mr. Elzéar Gauthier discovered zinc blende and galena on lots 39 and 40, range I, Montauban, about four miles south of the village Notre Dame des Anges. Since that date the area has attracted the attention of a small group of mining men. The present report and the accompanying geological sketch map are the result of two months of field work devoted to a geological study of those portions of Montauban and Chavigny townships and of the seigniory of Price within which occurrences of zinc blende, galena and copper pyrites have been found.

The base map was compiled from four separate copies of township maps, each on a scale of 40 chains to an inch, that were supplied by the Department of Lands and Forests of Quebec. The inaccurate character of at least important portions of these maps is reflected in the fact that the Batiscan river does not follow exactly the same course on any two of them. A new survey was not attempted, and the readjustments that proved to be necessary to

join these maps into one sheet were such that the caution must be expressed that the map accompanying this report should not be used as a basis for the accurate calculation of the areas of lots; especially must this be true of the lots bordering the river.

The position of the roads and of the geological boundaries were determined by using a prismatic compass and by pacing. The distribution of the sands and clays has not been delineated upon the map in great detail; but it was felt that the data that had been collected concerning this feature would show at a glance the approximate distribution of those lands upon which the prospector would search in vain for outcrops of rock.

Previous Geological Work.—In 1891, Dr. A. P. Low,[1] made a reconnaissance geological survey of the southern portions of the counties of Champlain and Portneuf. Concerning the area described in this report, he then wrote as follows.

"The Batiscan river was first descended from Laurentides Station to its mouth. The rock exposures along the river are numerous to within three miles of St. Geneviève where the country becomes low, and the river banks are cut out of deposits of stratified clay and sand."

"Along the upper part of the river, the rocks are tilted at high angles and are much contorted both in dip and strike; but throughout the part below Notre Dame des Anges, the dips are quite moderate and almost always toward the east. At Notre Dame, a large area of massive quartzite is seen having a breadth of over one thousand yards; this passes gradually into a light coloured quartzose mica gneiss on both sides. Quartz veins penetrate the quartzite and hold large crystals of a light coloured mica along with black tourmaline and hornblende. A small crystal of apatite was also found here. Some of the mica[2] is large enough to be of commercial value, but it is often considerably crumpled."

In 1898, Dr. R. W. Ells[3] prepared a report on "The Geology of the Three Rivers Map-Sheet" in which he incorporated a brief

---

[1]Report of the Geological Survey of Canada, Vol. V, Part 1, 1890-91, pp. 45AA-46AA.

[2]Note.—Within the area described in this report, no mica deposits of economic value were observed by the writer.

[3]Report of the Geological Survey of Canada, Vol. XI, 1898, pp. 45J-47J.

Key-Map showing relative position of area reported upon.

but somewhat more complete account of Low's observations. The geological map accompanying Ells' report is on a scale of four miles to the inch and depicts the area embraced by the present report as being underlain by "gneiss and granite," no distinction being drawn between gneisses of igneous origin and those developed by the metamorphism of stratified rocks.

Since 1910, Mr. T. C. Denis, the Superintendent of Mines in Quebec, has included brief descriptions of the character of the zinc deposits and of the progress of the prospecting work performed upon them in the Annual Reports on Mining Operations in the Province of Quebec.

Acknowledgments.—Grateful acknowledgment is due to both the officials of the Weedon Mining Company and to Mr. J. Thibault of the Montauban Mining Syndicate for the many ways in which they facilitated the study of the zinc and lead deposits of the area.

TOPOGRAPHY.

This area presents a pleasing combination of rugged rocky uplands and terraced lowlands, the latter being underlain by stratified clays, sands and gravels. Although situated within that great physiographic unit, known as the Laurentian Plateau, it lies so near its eastern margin that the hills are somewhat more variable in their altitudes than those that characterize a more typical expression of its topography. The white mass of granite and pegmatite, Hood's Mountain, which attains a height of approximately 1,050 feet above sea-level, is the most prominent of the hills in the vicinity of Notre Dame des Anges.

Climbing to the top of Hood's mountain and looking toward the north and west, one sees an even skyline (see Plate XIII) that portrays the uniformity in altitude of the hills in the more interior parts of this old dissected plateau—a uniformity that has been developed irrespective of wide diversity in the composition and structure of the underlying rocks. In these directions, it will also be observed that the terraced platforms of sand are comparatively narrow and confined to the valley of the Batiscan river, but toward the southwest, they progressively widen out to form broad level

areas that eventually merge with the flat or gently undulating lowlands bordering the St. Lawrence river. A succession of these terraces wind in and out, giving prominence to the numerous indentations in the contours of the hills in the background. Within the widespread tracts of level ground, rocky hills protrude in cameo-like relief from beneath the heavy blanket of stratified sands or clays, while long narrow outcrops of rock appear at the base of remnants of higher terraces.

The groups of hills composed of gneissoid granite comprise the most uniformly rough and barren portions of the area. Ridges, formed by the other rocks of the district, vary in the directions of their elongation in such a manner that they enwrap the large massive bodies of gneissoid granite.

The hills and ridges display smooth outlines, and in many localities the outcrops of rocks still retain that polished, striated and grooved appearance which developed from the abrasive action of the ice-sheet of the recent Glacial period. Irregular patches of polished surface are so dispersed on the granite forming Hood's mountain that there is no doubt that, when through the amelioration of the climate the ice-sheet disappeared from the area, the summit of this mountain then must have glistened as if it had been most thoroughly polished by arduous human effort. Since then, the polish has been in large part removed, or, where it has been retained, it displays a dull and irregularly pitted appearance caused by the prolonged action of weathering processes.

The stratified clays, sands and gravels were deposited in the waters of that irregular arm of the sea that, subsequent to the recession of the glacial ice of the Pleistocene period, flooded the valleys of the St. Lawrence, Ottawa and Richelieu rivers. The distribution of the terraced tracts of ground within the area described in this report illustrates the ragged character of the northern shore line of that sea. It was a fretted rugged shore fringed with a multitude of rocky islands.

That the land then stood at least 575 feet lower than it does today, and that the lower portions of the pre-glacial valleys of the present tributaries that enter the St. Lawrence river from the Laurentian plateau were then drowned and formed tidal estuaries is also illustrated by the valley of the Batiscan river. Although rem-

Looking towards the northwest, from the Summit of Hood's Mountain.

nants of higher terraces are here and there visible, the highest which really forms a prominent feature of the scenery in this area is that upon which the railway station of Notre Dame des Anges is situated. At an elevation 551 feet above sea level, or approximately 90 feet above the bridge crossing the Batiscan river to the main portion of the village, this broad platform of level sandy ground (see Plate XIV) is responsible for the existence of a considerable area of cultivable land on the northwestern side of the river. Northwestward from Notre Dame des Anges station, remnants of two slightly higher terraces are present. Extensive tracts of level land also possess the same elevation as Lac-au-Sable station with an elevation of 514 feet above sea level. Still other terraces possess elevations that vary from approximately 450 to 500 feet above the sea.

So deeply has the Batiscan river entrenched itself in its sediment-filled pre-glacial valley that it flows past the village of Notre Dame des Anges at a depth of about 130 feet below the highest terrace observed in the area. Rapids and waterfalls have developed where the river has exposed irregularities in the rocky floor on which the stratified sands and clays rest. Approximately, 550 yards above the bridge at Notre Dame des Anges, the river falls over gneissoid granite, in intrusive contact with highly altered sandstones and quartzites, to form the largest waterfall (see Plates XV and XVI) in the area. From a point a few hundred feet above this fall to a short distance below the bridge, the river flows swiftly and is broken by three cascades. The total descent is 69 feet. This water power is owned by the St. Maurice Lumber Company. For several years, this Company has kept a record of the variations of the flow of the river, and it is stated that at the lowest stage of the water, this water power is theoretically capable of developing 4,500 H.P.[1] About three miles below the bridge at Notre Dame des Anges, there is a cascade (called Chute No. 8), still the property of the Crown, which at extreme low water would yield about 850 H.P. Less important rapids also occur a few hundred yards above the bridge near Lac-au-Sable. The largest lake in the area, with a length of about three miles and a half and a maximum width of a mile is that from which the village of Lac-au-Sable receives its

[1]For further information apply to Mr. Robert Grant, Manager of the St. Maurice Lumber Company, Three Rivers, P.Q.

name. Numerous small lakes are scattered within the uplands from which small streams of clear water make their way to the Batiscan river. When these streams descend from the hills to the lower terraced lands of sand and clay, they cut deep V-shaped valleys that frequently possess widths of 100 yards or more and attain depths of from 40 to 80 feet. Many coulées of similar proportions take their rise within the lower lands, where springs emanate at the junction between sands and underlying clays. Coulées that have originated in this manner terminate abruptly upstream in an amphitheatre enclosed by steep banks of stratified sands which are sometimes 40 feet or more in height. From beneath the sands, a brook, in some instances more than a foot across, emerges on a bed of clay. Such a coulée is rapidly retreating headwards through the continuous removal by the stream of the sands resting directly on the clay, followed by the caving in of the upper portions of the sand banks. The action of the wind in drifting the sand to lower levels greatly accelerates the headward recession of the valley. On lot 9, range I. S. W., Chavigny township, there is an excellent example of a valley which has developed in this manner (see Plate XVII). Farmers could do much to retard the further encroachment of such valleys upon level agricultural lands by dumping brush and stones at the point where the streams emerge. In traversing the otherwise level surface of the higher terraces, these valleys constitute rather formidable obstructions. To avoid encountering them repeatedly, the railway follows the innermost margin of the most extensive of the higher terraces for a distance of about two miles southwestward from Notre Dame des Anges station.

Such streams and springs that make their appearance from beneath the heavy blanket of sand, and wells that have been sunk through the sands to the clay, provide most excellent water for drinking purposes.

GENERAL GEOLOGY

In common with other portions of the extensive Laurentian plateau or "Canadian Shield," the bed-rock geology of this area belongs to one of the very earliest chapters in geological history. All of the rocks are of early Pre-Cambrian age.

A portion of the village of Notre-Dame-des-Anges—Note the well-developed terraces that are typical of at least the lower portion of the valley of the Batiscan river.

PLATE XV.

Falls on the Batiscan river, above the bridge at Notre-Dame-des-Anges.

PLATE XVI.

A closer view of the falls that are shown in plate XV.

In approaching Notre Dame des Anges by rail from Lac-au-Sable, one traverses a portion of a widespread district underlain by gray gneissoid granodiorite. In descending at the station, the long crest of white granite of Hood's Mountain, about two miles to the northeastward, next attracts attention. At the bridge crossing the Batiscan river, one will observe the sharp contrast between the dark, rusty, more foliated gneisses and the quartzites of exceptionally white colour. In many directions, typical outcrops of these quartzites appear in prominent positions—to the right of the larger waterfall above the bridge; just beyond Mr. Bertrand's house and not far removed from the right bank of the river below the bridge; and on the hill facing the village upon which the property of the Laurentide Mining Company is situated. At the large waterfall, the gneissoid granodiorite is found to be intrusive into the dark rusty gneisses and the quartzites. Thus by observing the the very features of the scenery in the vicinity of the village to which the visitor is most naturally drawn, a general knowledge of the character and the more important relationships of the rocks within the district may be obtained. More than one-half of the area is underlain by granitoid gneisses that intrude a complex of metamorphic rocks which, for by far the major part, are the altered equivalents of the sedimentary rocks of the Grenville Series, but it also includes some broad bands and irregular bodies of older intrusive gneisses. In places, tattered remnants of the extremely metamorphosed sedimentary series are interbanded with the latter gneisses; locally, the now gneissoid and schistose sedimentary rocks are riddled with small irregular bodies of intrusive gneisses that are fine to medium grained, intensely foliated and vary in composition from an acid granite to a diorite. In appearance and in mineralogical composition, some of the gneisses that must be regarded as of sedimentary origin are so similar to some of the finely foliated granitic gneisses that dovetail into them that it would require extremely detailed field work and a very large scale to the map to differentiate them. For example, a typical development of what were considered to be the older granitoid gneisses forms at least a large part of the ridge to the north of rivière Propre at the western end of Lac-au-Sable, where they include a remnant of massive beds of crystalline limestone and are locally traversed, parallel to their foliation, by abundant ribbons and bands of amphibolites. On lots 10 to 20,

range I, S. W., Chavigny township similar gneisses are in contact with the intrusive gneissoid granite that plainly belongs to one great period of batholithic advance. The older igneous gneisses are undoubtedly of the same age as that which further south within the Canadian Shield has been designated "Laurentian" gneiss, while it is possible that the more massive and uniform gneissoid granodiorite, which, occupying widespread portions of the area has been mapped separately, may be of much younger Pre-Cambrian age (possibly equivalent to that which in the western and central portions of the Canadian Shield has been called the Algoman granite). But it seems likewise possible that both the older and the younger gneisses belong to one and the same general period of granitic intrusion, that of the Laurentian gneiss, the earlier apophyses and even the peripheral parts of which had crystallized prior to being locally penetrated by a later advance of the more deeply seated portions of the batholiths that had remained molten. According to this conception, during a period of widespread ascent of granitic magmas, earlier dykes and apophyses and even peripheral portions of the batholiths may have solidified during a comparatively brief cessation in the advance, and later be metamorphosed through a renewal of diastrophism accompanied by a rising of the still liquid interior parts.

Within this area, the rocks comprising the Grenville Series are generally gneissoid, but, in addition, they include a few comparatively narrow bands of biotite schists. Although on both sides of the Batiscan river in the vicinity of Notre Dame des Anges, heavy bands of white quartzites form the most prominent member of the series, in reality, the quartzites are very subsidiary in areal extent to both the amphibolites and the more widespread fine-to-medium-grained quartzose biotite-gneisses that frequently are rusty in appearance and often are sillimanite-bearing or garnetiferous. Of specially petrographical interest are the gneisses that are rich in cordierite and the irregular band of what formerly were impure dolomitic limestones, now almost completely altered to tremolite, actinolite, pyroxene, phlogopite, wilsonite, etc., with which the occurrences of zinc, lead, copper and iron sulphides on lots 322-327 of range I of the Seigniory of Price, and lots 40-44 of range I of Montauban township are associated. What is apparently a continuation of this tremolite-bearing band was observed on lot 10,

PLATE XVII.

Typical valley of a stream which has cut deeply into a sandy terrace. Lot 9, range I, S.W., Chavigny township.

PLATE XVIII.

Typical exposure of white quartzites on lot 6, range I, S.W., Chavigny township.

range I, S. W. Chavigny. The small remnant of massively bedded crystalline limestones on the northern shore of the western end of Lac-au-Sable, which through processes of contact metamorphism has been partially replaced by epidote, diopside, garnet, and pyrrhotite with a few grains of chalcopyrite and an occasional crystal of arsenopyrite, constitutes the only other occurrence of limestone in the area. In so far as is known to the writer, no rock-type has been previously described that is identical with the peculiar nodular sillimanite gneiss that is most typically developed on the northern end of lot 9, range IV, S. W. Montauban, where it is intercalated between bands of white quartzites.

Apart from numerous dykes and small irregular bodies of pegmatite that intersect all of the other rock-types in the area, and the altered limestones described in the preceding paragraph, all of the rocks within the area display foliation. The strike of the foliation, both of the igneous and the metamorphosed sedimentary rocks, is very variable; especially is this true in the vicinity of the large intrusive bodies of granite where the strike changes in such a manner that it is ever parallel to the granite contacts. In localities removed from the granite, the strike varies from N. N. E. to N. E. The dip is almost universally at angles of more than 30 degrees toward the east and southeast.

The small remnant of limestone on the northern shore of the western end of lac au Sable has in part retained its original bedding planes. In some places, as on the southeastern portions of lots 6 to 8, range V, S. W. Montauban, the white quartzites are in true beds. The other metamorphosed sedimentary rocks are now gneissoid or schistose and are characterized by banding rather than bedding. The foliation is ever parallel to the strike and dip of the banding. Since it is also true that the foliation in the quartzites is parallel to the stratification, and since the bands of sillimanite-bearing and garnetiferous gneisses that are intercalated between the quartzites appear to be interstratified with the latter, it may be that in general the banded structures of the altered sedimentary rocks are parallel to the original bedding planes. Locally, these rocks are very much contorted both along the dip and strike; in some places, even the quartzites are intensely crumpled (see Plate XIX).

The remarkable continuity with which heavy bands of the white quartzites follow close to the margins of the bodies of gneissoid granodiorite constitutes one of the most interesting of the geological relations in this field. Apparently, because of their relatively greater resistance to diastrophism and to the attack of the ascending magma, the quartzites were the competent member of the stratigraphy that at least locally more or less controlled the contacts of the intrusive granitoid bodies. Very prominent in this connection is the heavy band of these quartzites, up to 300 feet across that enwraps the extensive body of gneissoid granite that occupies the southeastern portion of the map; even more prominent is the band of white quartzites that forms, as it were, the backbone of the narrow strip of metamorphosed sedimentary rocks that, dipping steeply beneath the white granite of Hood's mountain, separates it from the great area of darker gneissoid granite that extends toward the north and west.

The western margin of the early Palaeozoic rocks, that underlie the lowlands bordering the St. Lawrence river, is situated eight miles to the southeast of this area. It seems probable that during a portion of early Palaeozoic time (possibly from Upper Cambrian to Lower Devonian) this area was covered by a sea within which sandstones, limestones and shales were deposited in a sequence of formations similar to that of the Palaeozoic rocks beneath the St. Lawrence lowlands. During the late Palaeozoic, the Mesozoic and the Tertiary, the area was being subjected to processes of erosion which completely removed the blanket of earlier Palaeozoic rocks. To-day not a fragment of Palaeozoic rocks can be found within the area.

During the Pleistocene, the great ice sheet that moved outwards in all directions from the central portion of the Labrador peninsula, passed across this area toward S. E. The white granite forming Hood's mountain and, in many places, the white quartzites have retained polished and striated surfaces developed by the abrasive action of the ice.

In the hilly portions of the area, boulder clay is sparsely distributed, and extensive outcrops of rock are of frequent occurrence. Towards the close of the Glacial period, when the ice sheet had retired northward, the St. Lawrence valley was occupied by an arm

of the sea whose irregular western margin lay within this area. It was within the waters of the sea that the stratified sands and clays were deposited that form the terraced lowlands of this and adjacent districts. Although no fossils were found in these stratified superficial deposits, there seems to be no reason to doubt that they correspond to the Saxicava Sand and Leda Clay which are so frequently fossiliferous in many localities within the St. Lawrence lowlands.

Excellent sections of these stratified sands and clays are exposed in the deep coulées that intersect the higher terraces. The overlying sands, varying up to 60 feet in thickness, are present over by far the major portion of the terraced lowlands. In places, the sands are quite coarse and display false bedding. Much of the terrace upon which the village of Notre Dame des Anges is situated, is capped by a considerable thickness of very coarse gravel, in which the pebbles are frequently as large as cocoanuts. The less sandy and most fertile portions of the area lie to the westward in portions of the Seigniory of Price, where the soil is a rich loam. The stratified clays, beneath the sands, are only exposed in the deeper coulées, and locally, at the margins of the higher terraces or on the surface of the lowest lands. A very typical exposure of the stratified clays is situated at the northern end of the bridge crossing the Batiscan river near Lac-au-Sable. On lot 14, range V. S. W. of Montauban township, on the road from Notre Dame des Anges where a hill, which originally was so steep that considerable cutting was done to facilitate the passage of heavy teams from the railroad station to the mine, the underlying clays display a remarkable series of small folds and crenulations, the axes of which are inclined in such a manner as to demonstrate that they have been caused by a tendency of the plastic clay to creep or move slowly down the slope of the hill.

Since the retreat of the ice sheet, the land has risen at least 575 feet. The uplift took place in stages and thus at different levels, the retiring post-glacial sea hesitated in its retreat and developed terraces. The Batiscan river was likewise enabled to cut deeply into the great thickness of sands and clays that had been deposited within its pre-glacial valley, and by developing flood plains at successively lower levels established the terraces which form so striking a feature of its scenery.

Grenville Series.

Those portions of the area within which the distribution of the different rock varieties present has not been given, and which in the legend on the accompanying map have been designated as "undifferentiated" are underlain by a complex of gneisses and schists which, by far the major part, are the metamorphosed equivalents of the Grenville Series. In general, the Grenville Series of this district is distinguished from areas farther to the south within the Laurentian plateau because of the paucity of limestones and their altered equivalents. Here this series originally was represented chiefly by arenaceous and argillaceous rocks that through metamorphism have been recrystallized into gneisses and a few narrow schistose bands.

Light to dark gray quartzose-biotite-gneisses and quartzose biotite-hornblende-gneisses constitute the most common types. Many of these paragneisses are garnetiferous and some of them contain sillimanite and cordierite. In general, all of these gneisses are more fine-grained, more intensely foliated and, because of more frequent variations in their mineralogical composition, display more pronounced banding than the more massive gneissoid granodiorites that are described in detail on later pages of this report. Upon weathered surfaces, the paragneisses frequently possess a very rusty appearance because of the presence within them of abundantly disseminated grains of pyrrhotite and pyrite. These rusty gneisses are best developed on the rocky hills that rise on lots 6 to 8 and lots 10 to 13, range I, S.W., Chavigny. In many localities, close to their contacts with bodies of granite and granodiorite, the rusty character of the paragneisses is plainly due to the oxidation of the scattered grains of pyrite and pyrrhotite with which they were impregnated by solutions emanating from the cooling granitoid magmas. Conspicuous in this relation are the rusty gneisses on the north side of the bridge crossing the Batiscan river at Notre Dame des Anges.

There follows a brief discussion of the petrography of the more interesting rock-types that belong to the Grenville Series:—

Quartzites.—In many localities, the white quartzites, whose distribution has been delineated on the accompanying map, have

retained their original bedding. Their massive beds vary from a few inches to several feet in thickness. Usually they display a more or less distinct foliation because of the presence of flakes of muscovite. Some of the beds are separated by bands of quartzose biotite schist or gneiss that often contain sillimanite and, less frequently, small reddish garnets. A typical exposure of these quartzites is shown in Plate XVIII.

Examination of thin sections under the microscope shows that some of the thickest of the quartzite bands are composed of quartz grains and a very few small flakes of muscovite. In general, however, a few grains of orthoclase and microcline and a few minute rounded grains of zircon are also present. Occasionally, small flakes of biotite are widely scattered through the rock. The quartz grains display strong strain shadows. These quartzites have been so completely recrystallized that, with the exception of the small grains of zircon, no traces of the outlines of the original clastic quartz grains can now be distinguished. The quartz grains possess very irregular outlines; frequently several grains are penetrated by a ragged individual of muscovite.

In places, near the Batiscan river on lot 6, range I, S.W., Chavigny township, a gradual transition may be observed from the white quartzites to dark grey quartzose bands which are quite rich in biotite, muscovite and sillimanite. With an increase in the amount of feldspars and biotite present, these rocks pass into the quartzose biotite paragneisses and schists.

Quartzose Biotite-Gneisses.—Of light to dark grey colour, and fine to medium grained, these rocks are chiefly composed of variable proportions of quartz, biotite, plagioclase and orthoclase. Crystals and grains of red garnets, up to one-half an inch across are of very frequent occurrence. Common green hornblende, microcline, muscovite, epidote, pyrrhotite, and minute grains of zircon and needle-like crystals of apatite are frequently present as accessory constituents. In a very few instances, zoisite and calcite were found to be present.

Transverse to the strike, different bands of these rocks vary much in composition, dark bands which are very rich in ferromagnesian minerals alternating sharply with light quartzose bands. Some of the bands, distinguished from others by a greater abundance of biotite, are schistose in character. Hornblende, when

present, rarely equals and very seldom exceeds the amount of biotite. In very many localities, garnet crystals are profusely scattered within these rocks and stand out in relief upon weathered surfaces. Very rarely, a few widely scattered flakes of graphite are present in these gneisses. In a small prospect pit close to the boundary between lots 322 and 323, range I, of the township of Price, and northwest of the small body of pegmatite shown on the accompanying map, one of the planes of foliation in a garnetiferous biotite gneiss was observed to be in part coated with a thin film of graphite.

Sillimanite-Gneisses.—As illustrative of the variations in the petrographical character of this interesting group of rocks, a few typical specimens from different portions of the area will be described:

On lot 6, range I, S.W., Chavigny, about one hundred yards from the Batiscan river, a small prospect opening has been made in gneissoid rocks containing a few scattered grains of pyrite. In a hand specimen from here, quartz, biotite, muscovite and a few small red garnets are visible to the naked eye. In thin section, the rock is found to be composed chiefly of quartz, flakes of muscovite and biotite, numerous garnets, a very few grains of plagioclase feldspar and widely scattered small grains of magnetite and zircon. In addition, sillimanite is present in the form of tufted and matted aggregates of fibres and isolated narrow prismatic crystals that penetrate all of the other minerals except the magnetite and zircon. The garnet occurs as colourless grains with very irregular outlines which enclose individuals of all of the other constituents.

A dark gray gneissoid rock of rusty appearance from near the southern end of lot 7, range V, N.E., Montauban, was found to be composed of quartz, much biotite and muscovite, a little orthoclase, numerous garnets, a few ragged flakes of graphite, widely disseminnated grains of magnetite and pyrite, a few minute rounded grains of zircon and small prismatic crystals of apatite. Matted fibres of sillimanite penetrate the grains of quartz, feldspar, micas and garnet.

On the extreme southern portion of lots 7 and 8, range V, S.W., and the northern part of lots 9 and 10, range IV, S.W., Montauban, a band of peculiar nodular sillimanite gneiss is intercalated between

PLATE XIX.

Crumpled quartzites on lot 7, range I, S.W., Chavigny township.

PLATE XX.

Nodular-sillimanite gneiss on lot 9, range IV., S.W., Montauban township.

beds of white quartzites. This band of exceptionally interesting rock pinches and swells and on lot 9, close to its boundary with lot 10, range IV, S.W., attains a maximum width of about 25 feet. A portion of the exposure of the rock at this point is shown in Plate XX, while a fresh specimen is shown in Plate XXI. Abundant quartzose nodules of light gray colour and of sizes similar to almond nuts from which the shells have not been removed, stand out in relief upon weathered surfaces. Through weathering, many of the nodules have been liberated from the matrix and are lying loose upon the surface of the rock or at the base of the exposure. The matrix is a dark gray gneiss rich in biotite. When broken transverse to the foliation, the fracture traverses the numerous nodules as well as the matrix. The lenticular nodules are arranged with their longest axes parallel to the foliation.

In thin section under the microscope, the nodules are found to be composed of a mosaic of quartz grains with irregular outlines enclosing flakes of muscovite and both of these minerals are penetrated by a vast multitude of fibres of sillimanite. A few minute and rounded grains of zircon and widely scattered particles of magnetite also occur in the nodules. The dark matrix is composed of grains of quartz, abundant flakes of biotite, numerous grains of plagioclase, a very few flakes of muscovite and widely disseminated grains of magnetite and zircon. Both in the nodules and the matrix, the quartz grains display strong strain shadows.

In following along the strike it seems plain that this peculiar rock has developed by the metamorphism of bands of white quartzite, less than an inch in thickness that alternate with narrow bands of the dark biotite gneiss. The more brittle and resistant quartzite bands have been separated into the lenticular nodules.

Amphibolites.—A few dark grey to black bands of fine-to-medium grained amphibolites are intercalated with the paragneisses. A heavy band of these rocks crosses the Batiscan river about two hundred yards below Chute No. 8. In the vicinity of the contact of the most western arm of the batholith of gneissoid granodiorite, that to the north of the Batiscan river extends from Chavigny township into the seigniory of Grondines, similar amphibolites outcrop frequently. To the north of the western end of lac au Sable, dark

amphibolites, associated with a small remnant of highly altered limestone, are intruded by granitoid gneiss.

The chief constituents of the amphibolites are green hornblende and plagioclase, while quartz, orthoclase, biotite, calcite, magnetite and sphene are often present as accessory constituents.

In their report on "The Geology of the Haliburton and Bancroft Areas, Ontario,"[1] Adams and Barlow have shown that amphibolites may not only be derived from the metamorphism of gabbros, diabases, diorites, etc., but also by the alteration of limestones. They point out that: "The amphibolites originating in these two very diverse manners often resemble one another so closely that it is impossible to tell them apart. So that in many cases, when the origin of a body of amphibolite is not discoverable from its field relations, it is impossible to determine whether it is an altered igneous or a body of altered sediment."

At Lac-au-Sable, the field relations strongly suggest that the amphibolites there have been produced by the alteration of limestones. In some localities, as on lots 8-10, range V, S.W., Montauban, certain occurrences of amphibolites have plainly originated by the metamorphic processes to which dykes and small intrusive bodies of diorite have been subjected. In many localities, however, the field relations do not make plain the original character of these rocks.

Cordierite-Gneisses.—In so far as the writer is aware, the presence of cordierite in Canada has been described from only three localities. Its first occurrence was reported from Harcourt township, Ontario, where its presence in a gedrite-bearing amphibolite[2] was observed by Dr. F. D. Adams. It is also mentioned as occurring in spotted slates in the vicinity of granite contacts near Halifax City,[3] Nova Scotia. Specimens of cordierite, "which are sometimes two inches in diameter," have been collected in Baffin Land.[4]

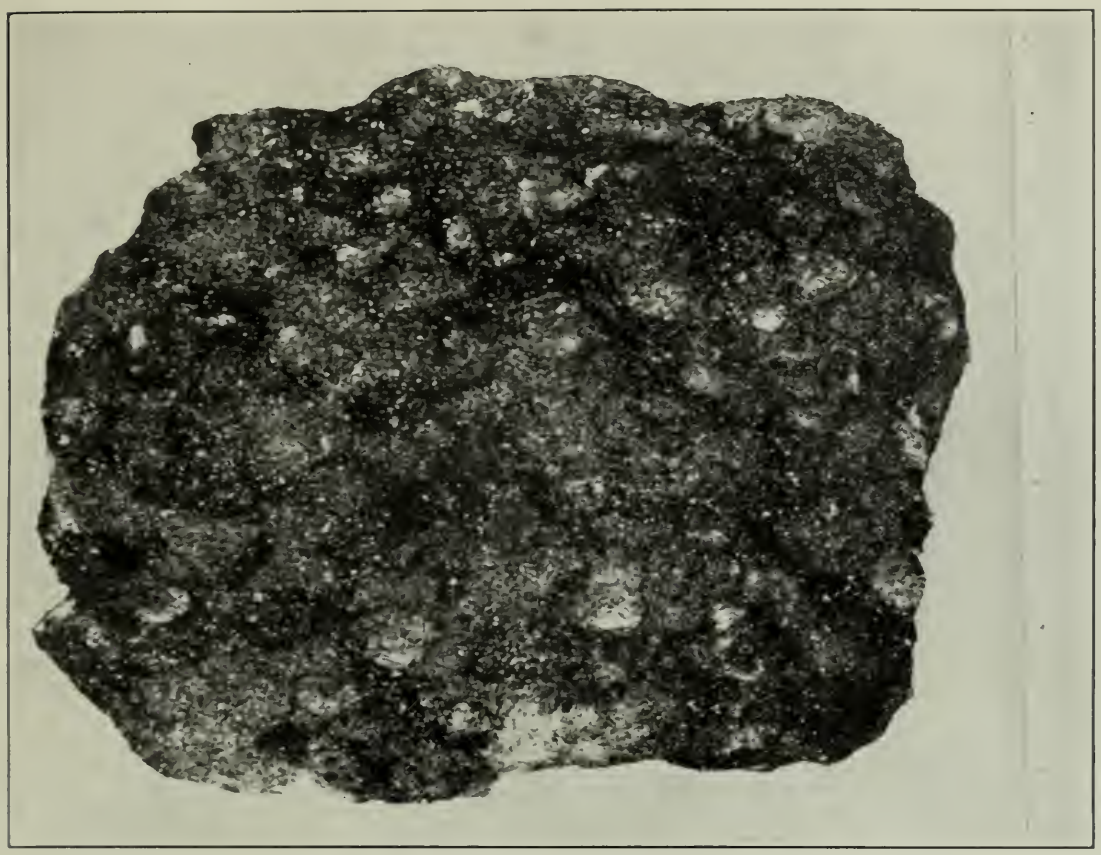
---

[1] Geological Survey of Canada, Memoir No. 6, 1910, pp. 157-172.

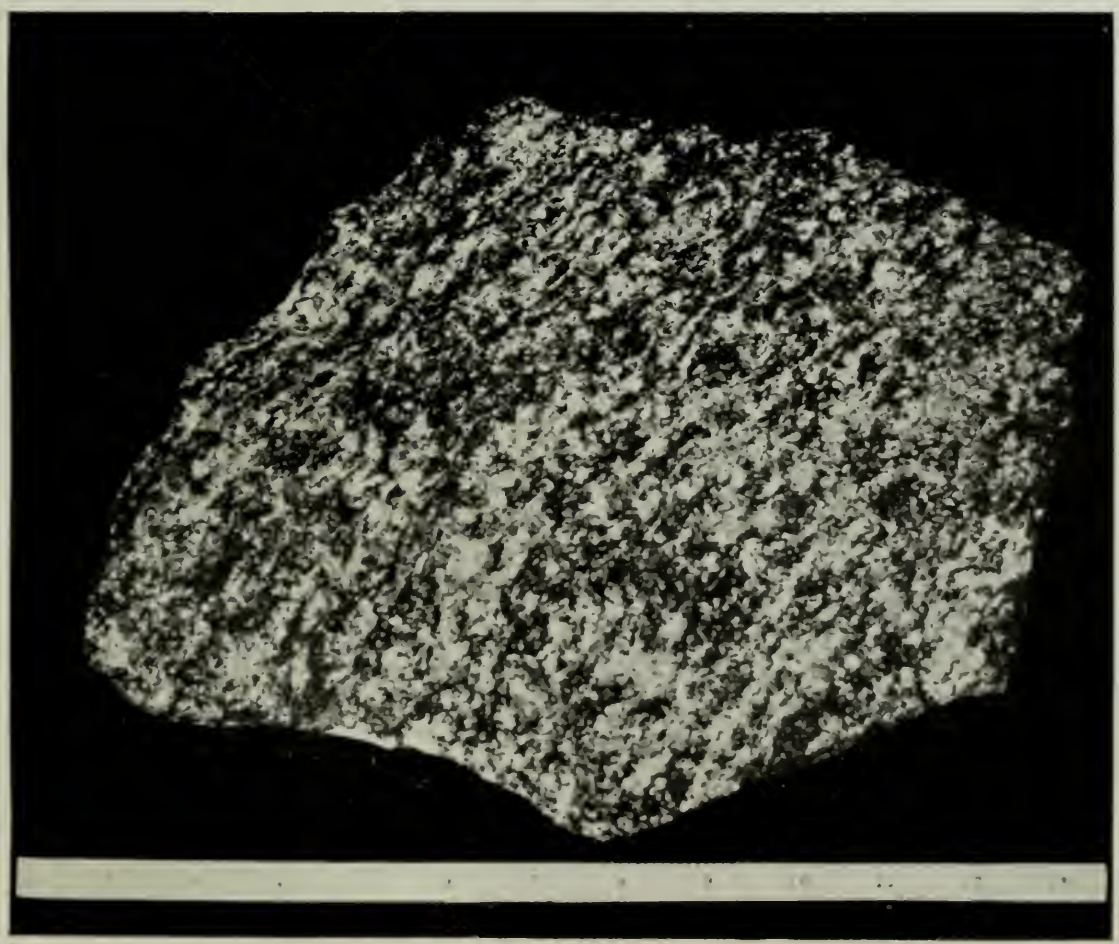
[2] "Geology of the Haliburton and Bancroft Areas, Ontario," by F. D. Adams and A. E. Barlow. G. S. C. Memoir No. 6, 1910, pp. 170-172.
"On the Occurrence of Gedrite in Canada," by N. Norton Evans and J. Austen Bancroft. Amer. Jour. of Sci., Vol. XXV, June, 1908, pp. 509-512.

[3] "A List of Canadian Mineral Occurrences," by R. A. A. Johnston, G. S. C. Memoir No. 74, p. 132.

[4] "Minerals from Baffin Land," by T. L. Walker. The Ottawa Naturalist, Aug.-Sept., 1915, p. 65.



Hand specimen of nodular-sillimanite gneiss—lot 9, range IV, S.W., Montauban township, scale in c.m.



Specimen of the typical gneissoid granodiorite, scale in c.m.

The heavy band of dark gray garnetiferous gneisses that extends across lots 41, 42 and 43, range I, S.W., Montauban township, striking from N 15 to 25° E and dipping steeply toward the southeast, contains much cordierite. These gneisses are exposed almost continuously from a low cliff, facing toward the southeast, near the boundary between lots 41 and 42 and thence cross the immediate corner of lots 42, 44 and 45 to beyond the shafts of the Montauban Mining Syndicate on lot 44. Near the boundary between lots 44 and 43, these gneisses enclose a band, varying up to more than 26 feet in thickness, that is composed chiefly of actinolite and small flakes of phlogopite together with quartz, cordierite, garnets and a few small crystals of spinel and rutile. Within this actinolite-rich band, small masses of cordierite of a bluish to smoky-gray colour were observed to attain a diameter of slightly more than an inch.

The gneiss is fine to medium-grained and varies in the depth of its gray colour according to its percentage of mica. Occasionally, portions of the gneiss are of a faint blue tinge because of the cordierite present; others are pinkish owing to an abundance of small grains and crystals of garnet. In thin section under the microscope, a specimen taken from a prospect opening near the boundary between lots 41 and 42 was found to be chiefly composed of cordierite, phlogopite and garnets together with some quartz and a few small crystals of sillimanite and zircon. A specimen of similar gneiss, from the northern shaft of the Montauban Mining Syndicate on lot 44, was found to contain the same mineral assemblage, and in addition, some small crystals of rutile, and a few ragged particles of graphite. The phlogopite is brownish-yellow in colour and frequently contains minute crystals of sillimanite and zircon, which are surrounded by pleochroic halos of a deeper brown shade. In the cordierite, numerous pleochroic spots of bright yellow colour mark the position of small inclusions of zircon and sillimanite. Along a complicated network of cracks, the cordierite shows incipient alteration to pinite.

A specimen of light bluish-gray schist, from the hanging wall at the bottom of the shaft of the Zinc Company Limited on lot 40, was found to consist chiefly of quartz and muscovite, with cordierite, needle-like crystals of sillimanite, small grains and crystals of rutile, and numerous grains of pyrrhotite.

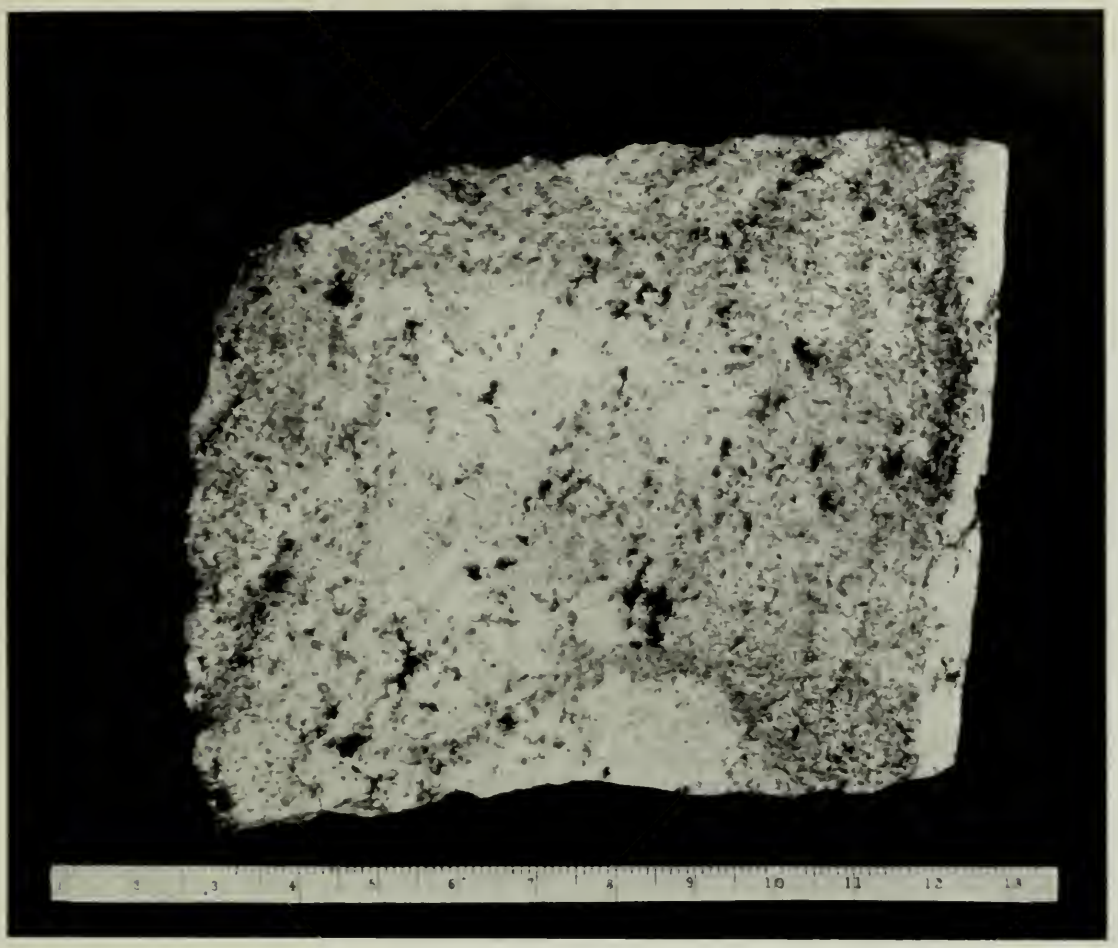
These cordierite-gneisses and schists were derived by the thermal metamorphism of sedimentary rocks that problably varied in composition from a sandstone with a dolomitic cement to a very sandy dolomite.

Altered Limestones.—The occurrences of altered limestones are so intimately connected with the ore deposits of the district that the description of these will be given under the heading of Economic Geology.

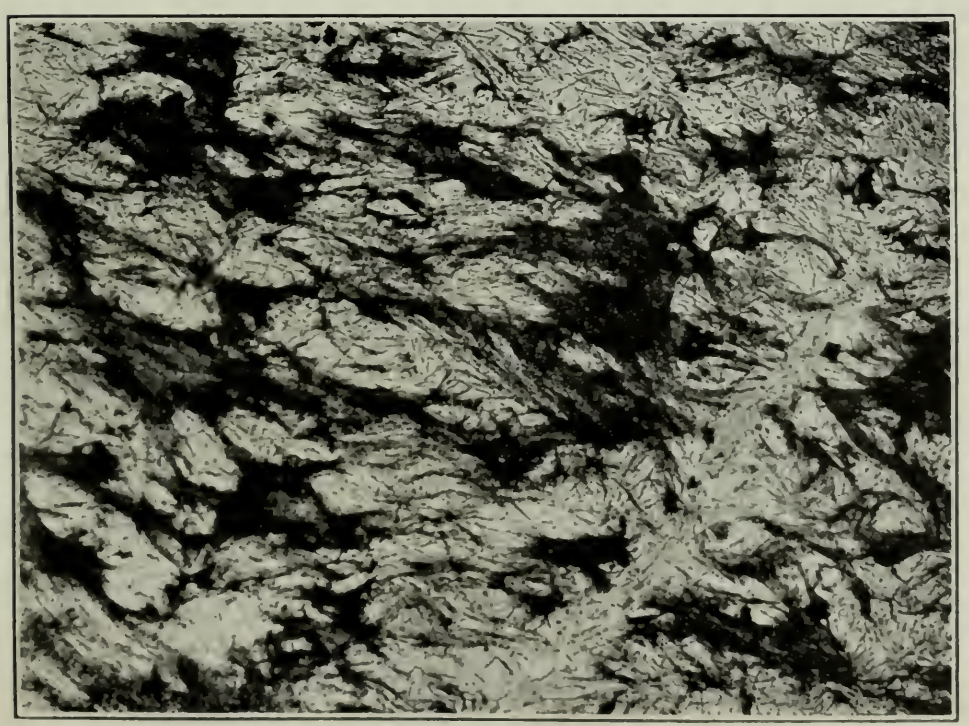
Laurentian Gneissoid Granodiorites and Granites.

Three areas stand out prominently upon the map as being underlain by granodiorite and granite. Towards the eastern portion of the map, these areas are separated from one another by narrow strips of the highly metamorphosed equivalents of arenaceous and argillaceous rocks of the Grenville Series. It may be that, farther to the north and east, these bodies of granodiorite will be found to merge in one large area of granitoid rocks. Even if this does not prove to be true, there seems to be no reason for doubting the belief that they, while in a molten state, have advanced simultaneously and are in reality portions of one great batholith which as yet has not been eroded to a sufficient depth in this locality to obliterate the roof pendants.

The body of granite that lies immediately north of Lac Pauvre, and the northwestern margin of which is known as Hood's mountain, is white in colour upon weathered surfaces, and is very acidic in its composition. The road that crosses lots 9 to 17, range V, N.E. of Montauban township follows the narrow strip of quartzites, sillimanite-bearing and garnetiferous gneisses and biotite schists that dip steeply beneath the white granite of Hood's mountain and separates it from the widespread development of gneissoid biotite-hornblende granite of grey colour that extends towards the north and west. Although in places this curtain of altered sedimentary rocks is less than one hundred yards in width and is traversed by numerous granitic dykes, there is no evidence to show that the two bodies of granite are not of the same age. The valley of the stream flowing from Lac à la Galette into the northeastern corner of Lac Pauvre is strewn with alluvium, and glacial debris;



Typical specimen of the granite of Hood's mountain, scale in c.m.



Photomicrograph of a nodule in the sillimanite gneiss.—showing fibrous sillimanite penetrating quartz and muscovite. Lot 9, range IV, S.W., Montauban township.

but, it is believed that this valley is underlain by a similar curtain of highly altered sedimentary rocks that, dipping towards the south-east, separates the white granite forming Hood's mountain from the great area of gneissoid granite that extends towards the north, east and south. In appearance and in petrographical character, the latter granite is identical with that which lies to the north and west of the road crossing lots 9 to 17, range V, N.E., Montauban. Thus, in so far as the present map is concerned, a large body of light coloured granite, the boundaries of which have been defined in part, lies between two other more extensive areas underlain by gneissoid granite which in general display remarkable uniformity in texture, foliation and mineralogical composition.

The typical gneissoid granite of these two areas is a fresh massive rock of a grey colour which is neither distinctively light or dark, and possessing a very marked foliation. In hand specimens (see Plate XXII), quartz, feldspar, biotite and hornblende are easily distinguished by the naked eye. In thin sections under the microscope, the rock is found to be composed of quartz, orthoclase, plagioclase, microcline, biotite, hornblende, a few irregular grains of sphene, epidote, magnetite and pyrite, and a few minute crystals of apatite and zircon; some of the feldspars exhibit incipient alteration to kaolin and sericite. In general, more biotite than hornblende is present. As indicative of the pressure to which the rock has been subjected, the quartz grains usually display strong strain shadows and often their marginal parts have been granulated. The percentage of plagioclase usually exceeds that of the orthoclase and microcline together. Although the rock is commonly known as granite and has frequently been referred to as such in previous portions of this report, according to more precise petrographical nomenclature, it should be called a gneissoid granodiorite.

In some places near its margin the northern body of granodiorite displays very striking variations in its mineralogical composition. For example, south of the western end of lac au Sable, on lots 24 and 25, range II, S.W., Chavigny township, a marginal phase of the granodiorite possesses the composition of a basic quartz-diorite. Here more than sixty per cent of the rock is composed of common green hornblende, while, in addition, biotite, plagioclase, a little quartz and a few grains of magnetite and pyrite are present. Very nearly black in colour, this quartz-diorite is cut

by numerous white or light grey dykes of aplite up to about a foot in width. In contrast, on the southeastern portions of lots 22 to 26, range II, S.W. of the same township, where the contact of the western extension of the northern body of granodiorite follows close to the Batiscan river, black amphibolites of the Grenville Series are cut by apophyses of the granodiorite that are light grey to white in colour and contain comparatively few scattered crystals of hornblende.

The typical granite of the intrusive body that lies to the north of Lac Pauvre is white or varies from yellow to a pale red in colour. The frequent rusty spots in the rock are due to the oxidation of disseminated grains and crystals of pyrite, some of which are one-fourth of an inch across. In hand specimens (see Plate XXIII) grains of feldspar, quartz, a little muscovite, usually a few flakes of biotite and occasionally a few small red crystals of garnet can easily be recognized by the unaided eye. In those specimens within which the biotite flakes are sufficiently numerous the rock is plainly foliated.

In thin section under the microscope, more than ninety-five per cent of the rock is found to be composed of quartz, microcline, plagioclase and orthoclase. The quartz often exhibits a strong tendency to graphic intergrowth with the feldspars. The majority of the quartz grains display strain shadows. The muscovite possesses ragged outlines, apparently having been derived from the feldspars through the action of pneumatolytic processes. The central portions of some of the garnet crystals are deep red in colour while their marginal parts are colourless. A few minute crystals of zircon and apatite are present in the rock. Some of the flakes of biotite have been altered to chlorite, while some of the feldspar grains are slightly turbid because of the development of sericite.

In many places on Hood's mountain the white granite passes gradually into irregular streaks of medium-grained pegmatite containing flakes of biotite and muscovite, some of which are more than an inch across. Especially towards the western end of the mountain, the white granite is cut by pegmatite dykes with sharp contacts, one of which was observed to have a width of two feet. In a few localities, irregular vein-like segregations of quartz, a few inches in

width and several feet or yards in length, traversing the granite, represent the acidic extreme of the cooling magma. It seems certain that the white granite of Hood's mountain is merely a pegmatite-like phase of the granodiorite and that farther toward the north and east, it may be expected to pass gradually into the typical gneissoid granodiorite of the area.

The gneissoid metamorphosed sediments or paragneisses are locally traversed by a large number of stringers, dykes, sheets and other small irregular intrusive bodies of gneissoid granitoid rocks that vary in composition from granites to diorites. Of these, aplite and pegmatite constitute the youngest rocks in the area. The majority of these intrusions are elongated in directions corresponding to the local strike of the enclosing rocks. In many places, the paragneisses are traversed, parallel to their foliation, by a vast multitude of minute stringers of granite and aplite, affording excellent examples of what is known as *lit par lit* injection. Almost all of aplite and pegmatite dykes possess irregular lenticular forms.

A typical specimen of the fine-grained aplite of very light grey colour was collected from a dyke on the northern side of the Batiscan river and immediately west of the bridge at Notre Dame des Anges. The rock possesses a distinct gneissoid structure made prominent by the alignment of the small flakes of biotite that it contains. In thin section under the microscope, it is found to be composed of microcline, orthoclase and quartz, a little plagioclase, a few flakes of biotite and muscovite and very sparsely distributed minute crystals of zircon and grains of black iron ore. The finely foliated appearance of the rock, the granulation of many of the grains of quartz and feldspar and the strong strain shadows that they display, make plain that the rock has been subjected to great pressure which undoubtedly was also responsible for changing the major portion of the orthoclase into microcline. Lenticular dykes of similar character to the rock-type just described are abundant within the area. On the accompanying map, the approximate positions of two of the larger of these dykes are shown on lot 3, range V, S.W., and on the boundary line between lots 9 and 10, range IV, S.W. of Montauban township.

Very numerous and very prominent because of their white colour and coarse grain are the dykes and lenticular sheet-like bodies of

pegmatite that cut the paragneisses of the Grenville Series. In many instances, the bodies of pegmatite have resisted the weathering processes better than the rocks that enclose them and consequently they stand out in relief as small knob-like hills or narrow ridges that form striking landmarks. In some places, isolated knobs of pegmatite protrude from beneath the heavy blanket of sands and clays that cover extensive portions of the area. Since the majority of the dykes of pegmatite are comparatively small and irregular and since their number is legion, the positions of only a few of the larger bodies are shown on the map accompanying this report—as on lots 309 and 322 range I, Price; lots 38 and 39 range I, S.W., lots 33, 34 and 35, range II, S.W., lots 9 and 10, range V, S.W., Montauban township; lots 16 and 17 range I, S.W., Chavigny township.

The pegmatites are composed chiefly of coarse grains of feldspar and quartz. In a very few places some of the feldspar individuals attain dimensions of several inches. Orthoclase, microcline and plagioclase are present, and in at least some instances the plagioclase, varying in composition from albite to oligoclase, is more abundant than the orthoclase. Flakes of muscovite are of frequent occurrence, but seldom do they exceed an inch in diameter; occasionally a few scattered flakes are from one to two inches across. In a few localities, the pegmatites contain scattered individuals of biotite that vary in size similarly to the muscovite. Small red garnets up to half an inch across, and crystals of black tourmaline, up to seven inches in length and two inches across, are of very frequent occurrence in the pegmatites. In many instances small prospect openings have been made in pegmatite dykes in the belief that the black tourmaline was a valuable mineral; some prospectors confused the black tourmaline with black zinc blende.

ECONOMIC GEOLOGY

The occurrences of zinc blende and galena within this area are chiefly confined to a portion of a zone of highly altered sedimentary rocks, which, with a length of nearly two miles and with a strike that varies from N. 10° to 35° E, dips steeply toward the southeast, and extends across lots 322-327, range I, Price, and lots 39-45, range I, S.W., and into Block C, range II, S.W., of Montauban township.

On lot 322, Price, these rocks emerge from beneath a very heavy covering of sands and clays that occupies an extensive area toward the south. Originally, these rocks were sandstones and impure dolomitic limestones. Through processes of thermal metamorphism the sandstones have been changed into paragneisses, quartzites and mica schists; the limestones have been almost completely converted into tremolite, diopside, phlogopite, actinolite, etc.

Overlying these altered sedimentary rocks, there is a fine-to medium-grained gneiss that has the composition of a biotite-hornblende granite. In thin section under the microscope, this gneiss is found to be composed of quartz, orthoclase, microcline, plagioclase, biotite, greenish hornblende, a few grains of epidote, zoisite, sphene, and black iron ore and a few minute crystals of zircon and apatite. The upper contact of this sheet-like body of gneissoid granitoid rocks is not exposed, since, towards the south and east, the ridge which they form descends to the flat plain that is occupied by a great thickness of stratified sands and clays. Crossing the Batiscan river at Chute No. 8, and forming the "hanging-wall" of the zone of rocks within which zinc blende and galena may be found, these gneisses may be traced almost continuously for at least slightly more than two miles toward the southeast. Their strike and dip correspond to that of the rocks beneath. Varying from light to dark grey in colour, these gneisses are intensely foliated; many of the planes of foliation are so prominent that they simulate the planes of bedding in stratified rocks. Their intrusive contact with the underlying metamorphosed sedimentary rocks is irregular; in some places they are in direct contact with the band of altered limestones, while in other places they are separated from it by variable thicknesses of paragneisses. The biotite-hornblende gneisses are intersected by numerous irregular pegmatite dykes, some of which on lots 38, 39 and 40, range I, S.W., Montauban, attain large proportions.

To the southwest and beneath the zone of mineralized rocks are paragneisses that are riddled with small intrusions of granitoid gneiss, which are always elongated in the direction of the prevailing strike.

From lot 322, range I, Price, into lot 41, range II, S.W., Montauban, the mineralization is confined to a band of altered lime-

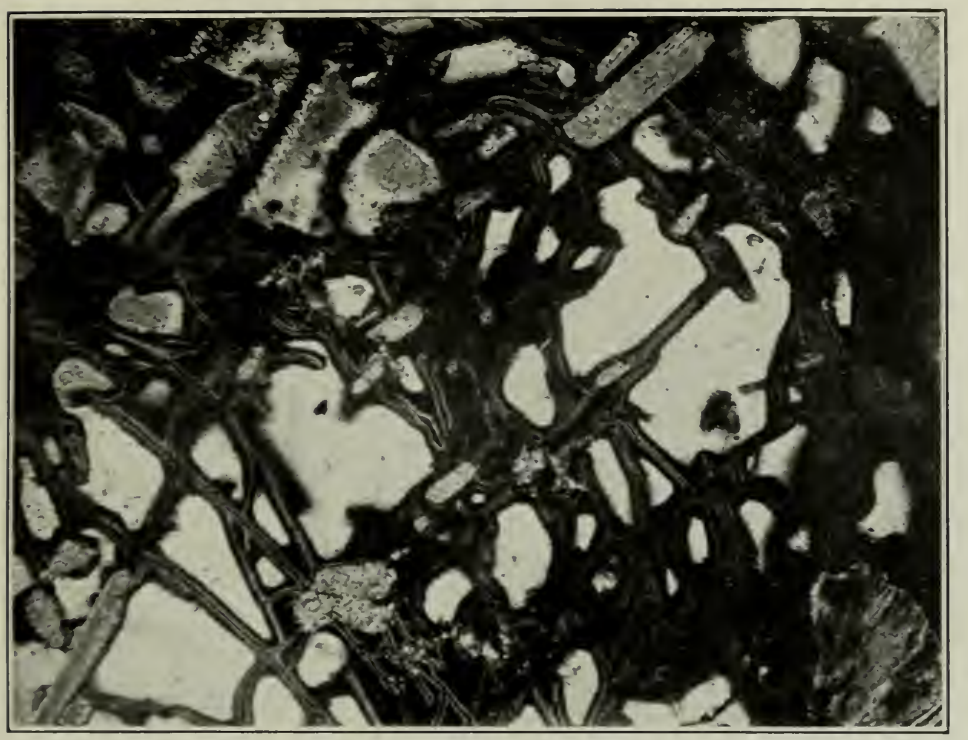
stones that varies from a few feet to 60 feet in width and locally includes certain narrow bands of quartzites and mica schists. In general, the limestone has lost all semblance of its original character, since it has been changed chiefly into tremolite together with diopside, phlogopite, biotite, actinolite, scapolite, wilsonite, anorthite, apatite, epidote, garnet, titanite, quartz, and recrystallized calcite and dolomite; a little chlorite and talc have been developed locally, because of the alteration of the micas. This band is irregularly mineralized with zinc blende, galena and pyrrhotite, and a few scattered grains of pyrite and chalcopyrite; in some places, small crystals of arsenopyrite and a few small flakes of molybdenite and of graphite have also been found.

In a very few places and especially in a small opening close to the boundary between lots 323 and 324, range I, Price, the crystalline limestone contains a relatively small proportion of the minerals that have been developed through processes of contact metamorphism. Where the band locally widens, it is more completely changed to these minerals towards its hanging-wall than in its lower portions. In general, however, the altered band of impure dolomitic limestones now consists of a closely matted aggregate of fibrous tremolite within which the other minerals mentioned are irregularly distributed.

Closely packed aggregates of fibres and blade-like crystals of the white to dark grey tremolite (see Plate XXVI) are often arranged in a radial manner. The light green actinolite is also both fibrous and in blade-like crystals; where they penetrate coarsely crystalline calcite, some narrow, transparent actinolite crystals attain a length of several inches, and are of a beautiful olive-green shade.

A light grey to greyish-green pyroxene, probably diopside, is present in granular form and also as crystals, of which the largest observed was three inches across and ten inches in length. Many of the small crystals, less than two inches long and a half an inch in thickness, are colourless and transparent. The prismatic faces of all of these crystals are smooth and brilliant, but, when present, the terminal faces are dull and rounded.

The phlogopite varies from dark brown to white in colour and is present both in the form of abundantly disseminated small flakes and, associated with biotite, as contorted bands, which locally at-



Photomicrograph of cordierite partially altered to pinite—from a cordierite-gneiss on lot 44, range I, S.W., Montauban township.

PLATE XXVI.

Tremolite containing small amount of zinc blende and galena, scale in c.m.

tain a thickness of slightly more than two feet. Occasionally certain streaks within these micaceous bands have been partially altered to talc and chlorite.

Irregular masses of a mineral of a rose-red to peach-blossom red colour are of frequent occurrences. They are especially abundant about one hundred feet north of the large open-cut near the line between lots 40 and 41, Montauban, and in the vicinity of the small prospect opening near the boundary between lots 323 and 324, Price. Very large specimens of this mineral may be collected near the footwall on the second level and to the north of the shaft of the Zinc Company, Limited. Specimens of this mineral were submitted to Mr. R. P. D. Graham, Assistant-Professor of Mineralogy at McGill University, who found that in all its properties it corresponds to wilsonite.

A few crystals of the plagioclase feldspar, anorthite, are occasionally present; one of these, with imperfectly developed faces had a maximum length of three inches and was about an inch across. Crystals of bluish-green apatite, up to two inches in length and half an inch in thickness are of rare occurrence. A very few crystals and small rounded masses of garnet are also found. The garnet, which probably belongs to the variety andradite, is usually light red in colour; one transparent crystal, about a half an inch across, was exceptional because of its pale-yellow colour. In some places, epidote occurs in the form of small grains of light green colour. Two specimens from the shaft of the Zinc Company, Limited, contained small black wedge-shaped crystals and grains of titanite. Quartz is present in the form of disseminated grains, segregated masses and stringers. Irregular pockets and bands of calcite and dolomite are distributed through the tremolite.

Minute flakes of graphite are of very rare occurrence; in one or two instances, a few fibres and blade-like crystals of tremolite were observed to be partially coated with an extremely thin film of graphite. Both on the dump at the shaft of the Zinc Company, Limited, and also in the open-cut close to the boundary between lots 40 and 41, a few small crystals of arsenopyrite, up to an inch in length, were observed within some of the most tremolite-rich portions of the rock. In the latter locality, a few small flakes of molybdenite were found both in quartz and in the tremolite. When

ore from this open-cut was being passed through the mill, a few small nuggets of native gold were found by Mr. Tétreault on one of the Wilfley tables.

Zinc blende, together with much less amounts of galena and pyrrhotite and a few scattered particles of pyrite and chalcopyrite are very irregularly disseminated through portions of the altered band of limestones. In those portions of the band that have been almost completely changed to tremolite and diopside, pockets of very rich ore occur. These pockets vary in size from a small "nest" to those that will yield several hundred tons of ore that may carry from 40 to 52 per cent of zinc and a few per cent of lead. In all directions from these bodies of rich ore, the zinc blende and galena are more and more sparsely disseminated, and, within a few feet or yards, barren rock may be reached. It is within or near the margins of these pockets or nests of ore that fresh, perfectly developed crystals of diopside are frequently abundant. Some of the diopside crystals are fractured, and within the cracks the metallic sulphides are present; otherwise, only the outer portions of the crystals include grains of the sulphides. Apparently, under the processes of contact metamorphism, the tremolite and the diopside crystals were almost completely developed before the deposition of the zinc blende, galena and chalcopyrite began. On the first and second levels of the mine of the Zinc Company, Limited, where for a length of more than two hundred feet along the footwall, the crystalline limestone, for a thickness of about fifteen feet, is comparatively free from tremolite, diopside, etc., these metallic sulphides are quite uniformly distributed.

History.

In July, 1910, Mr. Elzéar Gauthier of Notre Dame des Anges discovered zinc blende and galena on lot 39, range I, S.W., Montauban township. In 1911, Mr. Pierre Tétreault acquired that portion of the mineralized zone crossing lots 322-327, range I, Price and lots 39-42, range I, S.W. Montauban. In 1912, Mr. Tétreault erected a concentrating mill on lot 40, with the hope of treating the complex ores of this area by the methods that are adopted in concentrating the zinc and lead ores of the Joplin district, Missouri. In 1913 and 1914, about 1300 tons of high-grade

ore were shipped from rich pockets that were encountered in shafts 3 and 4, but the mill failed to produce a marketable grade of concentrates. The mineralized zone was then found to extend northeastward across lots 45, 44, 43 and into Block C, range I, S.W., Montauban, and other deposits of zinc blende were discovered on lots 7 and 8, range IV, S.W., Montauban. In 1914, the Laurentide Mining Company began prospecting operations on lots 7 and 8, range IV, S.W., and the Montauban Mining Syndicate started work on lot 43, range I, S.W.

In October, 1914, the Weedon Mining Company, who own and operate the large deposit of cupriferous pyrite in the Eastern Townships, P.Q., leased from Mr. Tétreault a portion of the mineralized zone, 900 feet in length, immediately south of the small lake on lot 40, and including shaft No. 3 which was then about 90 feet deep. Ably directed by Mr. L. D. Adams, the Superintendent of the Weedon Mining Company, development work was vigorously carried on, the concentrating mill was remodelled, and, as a result of numerous experiments, a method was devised whereby the ore can now be economically concentrated. In 1915, a separate company, the Zinc Company, Limited, was incorporated to operate this property. Up to June 1st, 1916, they had shipped 300 tons of high-grade zinc ore, and had passed 6958 tons of ore through the mill, which yielded 1225 tons of zinc concentrates with an average content of 42 per cent of zinc, 10 per cent of iron and 4 per cent of lead, and 270 tons of lead concentrates, containing 63 per cent of lead, and carrying 60 ounces of silver and about $10 in gold per ton of 2000 lbs. In the spring of 1916, this Company started the construction of a new concentrating mill which, when completed in July, will have a capacity of treating 200 tons of ore per day.

Neither the Laurentide Mining Company or the Montauban Mining Syndicate have shipped any ore.

The Tetreault Property.—Southward from the small lake on lot 40, range I, S.W., Montauban township.

Southward from the margin of this lake, the mineralization is practically confined to the band of metamorphosed magnesian limestone whose position is plainly marked by a depression. For about 400 feet from the lake, the altered limestones vary from 35

to 60 feet in width when, including a band of quartzites up to 15 feet in width, they fork into two bands which gradually become narrower as they are followed along the strike. Judging from surface exposures, it would appear that for a distance of about 500 feet southward from the lake, the altered limestones can be successfully worked for their irregularly distributed content of zinc blende and galena; farther southward only a few widely scattered grains of these minerals have been found.

In the southwestern corner of lot 40, at the hanging wall of the band of altered limestones, Mr. Tétreault sank a shaft (No. 3) to a depth of about 90 feet on a slope of about 60 degrees toward the southeast, on a large pocket of very rich zinc ore carrying a small percentage of lead. At a depth of 33 feet, drifting was extended for about 145 feet toward the southwest. Seven or eight feet from the shaft a stope was developed which attained a maximum height of about 20 feet. Fifty-five feet southwest of the shaft a raise was extended to the surface. Between 1200 and 1300 tons of high grade zinc ore were shipped by Mr. Tétreault from this shaft.

The Zinc Company, Limited.—In October, 1914, the Zinc Company, Limited, leased shaft No. 3 from Mr. Tétreault and that portion of the mineralized zone extending 100 feet northward and 800 feet southward from this shaft. The shaft has been extended to a depth of 175 feet.

At a depth of 85 feet, drifting has been carried about 325 feet towards the south. For about 160 feet from the shaft, the drift is crooked and lies toward the hanging wall of the altered limestones where they are almost completely altered to tremolite, diopside, etc., within which the zinc blende and galena are disseminated in an extremely irregular manner; beyond this, the drift followed the footwall where the ore is less irregularly distributed. At a distance of about 160 feet from the shaft, while raising to the surface, a rich pocket of ore was encountered from which about 300 tons of an excellent grade of ore were obtained.

At a depth of 170 feet, drifts have been extended toward the north for 100 feet and toward the south for about 225 feet. In the latter direction, the drift has followed quite close to the footwall, where the crystalline limestone is almost completely free

Shaft-house of the Zinc Company, Limited. Lots 39 and 40, range I, S.W., Montauban township.

from tremolite ,diopside, etc., but is heavily mineralized with zinc blende, galena, pyrrhotite and a very few grains of chalcopyrite. Undoubtedly, some pockets of rich ore will be found to be very irregularly distributed within the more tremolite-rich portion towards the hanging wall. Northward from the shaft, the band of altered limestones is narrower and more irregularly mineralized.

In the course of this development work, 6958 tons of ore, with an average content of 13 per cent of zinc, 9 per cent of iron and 3 per cent of lead have been passed through the remodelled mill that originally had been erected by Mr. Tétreault. This ore yielded 1225 tons of zinc concentrates carrying 42 per cent of zinc, 10 per cent of iron and 4 per cent of lead; also 270 tons of lead, concentrates with an average content of 63% of lead, 10 per cent of iron, 8 per cent of zinc, and carrying 60 ounces of silver, and about $10 in gold per ton of 2000 pounds. It would seem to be a conservative estimate that on June 1st, 1916, about 50,000 tons of ore of similar average grade to that milled has been blocked out in the mine. In July, they hope to have their new concentrating mill in operation which will enable them to treat about 200 tons of ore per day.

Northward from the small lake on lot 40, the mineralized band of altered magnesian limestones first emerges from the low land surrounding the lake at a point where it has been exposed during the excavation for the foundation of the old compressor house. Just beneath the western portion of this building, an isolated outcrop shows that here some rich ore is present. Although the exact width of the band could not be determined, it is plain that it is much narrower than to the south of the lake.

For 120 feet farther to the northward, the biotite-hornblende-gneiss of the hanging wall and the light grey quartzites of the foot-wall come so close together that the tremolite-bearing band is very narrow. At this distance north of the old compressor house, where a pocket of rich zinc ore outcropped, a vertical shaft (7′x 11′) known as shaft No. 4, was sunk to a depth of 57 feet. For 7 or 8 feet from the surface, the shaft penetrated ore of such a character that seven or eight tons of very high-grade zinc ore were shipped, but because of the dip toward the east of the mineralized band, which here does not exceed three feet in width, the shaft then passed

into the barren quartzites of the footwall. At present this shaft is being used as the source of the drinking water for the camp.

About 300 feet to the north of shaft No. 4, and close to the boundary between lots 40 and 41, a large open cut has been made where the altered limestones, almost completely changed to tremolite, diopside, etc., and apparently having a width of slightly more than 50 feet, form a cliff about 20 feet high, which faces toward the westward. In front of the cliff, there is a hollow within which no rocks are exposed, but from an examination of adjacent exposures, it would appear that this low-lying ground is underlain by mica-schists, the altered equivalent of quartzites, that may enclose some tremolite-bearing bands.

Within the open cut two shafts have been sunk. When examined by the writer, the position of one of these shafts (No. 1) was covered with loose rock, while the other (No. 2) was full of water. The following data concerning the workings were kindly furnished by Mr. P. Tétreault, Jr. When the open cut was comparatively small, a vertical shaft (No. 1) was sunk to a depth of 54 feet. Fifty feet from the surface a cross cut was driven toward the west for 36 feet, but no ore was encountered. The open cut was then extended for 33 feet into the cliff, until the hanging wall of quartzose biotite-gneiss was met with. If the small amount of loose rock were removed from its floor, the open cut would have a maximum depth of 22 feet. Immediately beneath the hanging wall, an inclined shaft (No. 2) was sunk to a depth of 63 feet below the bottom of the open cut; this shaft dips 40 degrees for the first 35 feet, when it steepens to about 60 degrees. At a depth of 51 feet, a cross-cut, 77 feet in length was driven toward the west to connect with shaft No. 1. This crosscut penetrated about 22 feet of ore that Mr. Tétreault estimates would average from 12 to 15 per cent of zinc and a small amount of lead; included within this estimate is a streak from four to five feet in width that probably carries from 30 to 35 per cent of zinc. At a depth of 51 feet in shaft No. 2, a drift was also extended for about 50 feet toward the south, but very little ore was encountered.

The open-cut has been made in a comparatively large pocket of excellent ore. The extremely irregular character of the mineralization is well displayed upon the walls. Surface exposures would indicate that within a few yards, either toward the north or south,

this exceptionally rich ore will gradually pass into irregularly disseminated ore of a very much inferior grade.

On June 12th, 1916, a group of men under the direction of Mr. P. Tétreault, Jr., were engaged in re-opening shaft No. 1.

Across lots 41 and 42, a shallow depression extends, and marks the position of the zone within which zinc and lead minerals may be found. Here the zone attains a maximum width of about 300 feet. To the eastward, the barren biotite-hornblende-gneiss, forms a low but prominent cliff which in places is overhanging. The depression is underlain by garnetiferous gneisses which in part are rich in cordierite, and by gray mica-schists. Locally, these rocks are cut by narrow dykes of pegmatite. From near the boundary between lots 41 and 42 across lot 42 and the southeastern corner of lot 45, massive garnetiferous cordierite-gneisses form the margin of the higher ground that borders the northwestern side of the depression. Northward from the open-cut, near the boundary between lots 40 and 41, the tremolite-bearing band can be traced for about 250 feet when it loses its distinctive character and appears to pass gradually into the garnetiferous cordierite-gneisses which enclose certain bands that contain much actinolite and phlogopite.

Within this depression on lots 41 and 42, several shallow openings have been made which show that zinc-blende, galena, pyrrhotite and a little chalcopyrite are of frequent occurrence in these rocks. Scattered grains of these minerals appear along some of the planes of foliation; occasionally certain narrow bands of the gneiss are irregularly impregnated with disseminated particles of these sulphides; less frequently veinlets which do not exceed an inch in width, chiefly composed of zinc-blende and galena, trend parallel to the foliation. Here no discoveries have as yet been made that can form the basis for a successful mining entreprise. The most efficient method that could be adopted in prospecting would be to expose the bed-rock in trenches at right angles to the depression.

The Montauban Mining Syndicate.—Lots 43, 44 and 45, range I, S.W., Montauban.

That portion of the mineralized zone which crosses the southeastern corner of lot 45 and the southern portions of lots 44 and 43 is controlled by a group of men from Massachusetts, U.S.A., who

have organized the Montauban Mining Syndicate with Mr. E. J. Thibault as manager. They began work on the property in August, 1914.

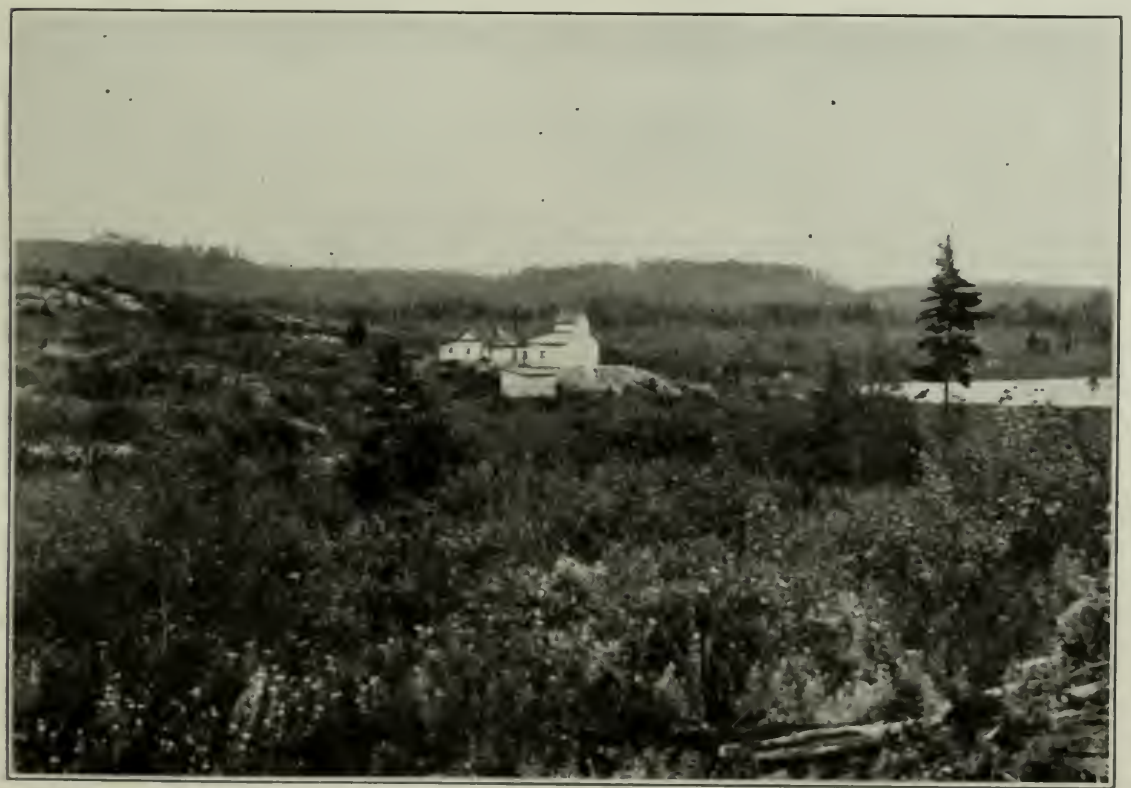
The dark grey gneisses, rich in small pink garnets and phlogopite, and often carrying cordierite and occasionally some actinolite, strike N 15° to 20° E and dip at angles that vary from 10° to 50° toward the southeast. At least, near the line between lots 43 and 44, these gneisses enclose a band, the true width of which has not been exposed, which is composed chiefly of phlogopite, actinolite, cordierite, and quartz and within which a few crystals of anorthite, rutile, spinel, arsenopyrite, and a very few flakes of molybdenite are present. Here, with a width of approximately 300 feet, the gneisses, within which zinc blende, galena and chalcopyrite may be found, occupy higher ground which gradually descends toward the north and east. The gneisses are crumpled into broad rolls both along the strike and parallel to the dip. Irregularly lenticular veins of black zinc blende, galena, pyrrhotite and chalcopyrite are enclosed within the gneiss parallel to its foliation. Occasionally, the veins contain much quartz, but, in general, they are composed chiefly of zinc blende with much less galena, chalcopyrite, pyrrhotite and a little pyrite. In addition to the veins, certain narrow bands of the gneiss are very irregularly mineralized with the metallic sulphides mentioned. In tracing either the veins or the mineralized bands along the strike, they are found to pinch and swell in an extremely irregular manner. For several yards they may be an inch or two in width and then for a few feet or yards may widen out until they may attain a maximum width of between two and three feet. In following them down along the dip, they similarly pinch and swell, but more or less in sympathy with the "rolls" of the gneiss. Some of the veins are only a few feet long; none have been found that exceed 120 feet in length. The extremely irregular distribution and character of the mineralization is best illustrated by a detailed description of the workings.

About two hundred yards from the southeastern boundary of lot 44, and approximately 15 yards from the line which separates it from lot 43, a vertical shaft (6′ x 11′) has been sunk to a depth of 50 feet. Work commenced upon an outcrop of the garnetiferous cordierite-gneisses enclosing a vein of the metallic sulphides which is said to have had a true thickness of about two feet. The gneiss

PLATE XXVIII.

Prospect of the Montauban Mining Syndicate, on lot 44, range I, S.W., Montauban township.

PLATE XXIX.



Prospect of the Laurentide Mining Company, on lot 7, range IV, S.W. Montauban township.

is dipping from 35° to 40° toward the southeast. Twenty-eight feet from the surface a crosscut was driven towards the southeast for seven feet and a drift, 22 feet in length, was extended toward the southeast following a few narrow irregular stringers of zinc blende, with a little galena and pyrrhotite. At its bottom, the shaft has penetrated a band containing much phlogopite and actinolite, which is apparently identical with that exposed in an opening on lot 43 near its boudary with lot 44.

From the bottom of the shaft, a crosscut has been extended for 68 feet toward the southeast. Seven or eight feet in from the shaft, a vein of the metallic sulphides mentioned has a width of from 8 to 22 inches on the roof of the cross-cut, but on following it along the dip to the floor, it is found to diminish to 2 or 3 inches in thickness. This vein proved to be even more irregular in the drift which here followed it for 50 feet toward the southwest where it apparently has completely pinched out.

Twenty-three feet within the crosscut from the shaft, the gneiss for a width of four feet is traversed parallel to its foliation by a large number of stringers of compact white granular quartz which contain only a few specks of zinc blende and galena.

Forty-four feet from the shaft, the cross-cut penetrated a band of the gneiss which, varying from a few inches to three feet in width, is very irregularly mineralized with chalcopyrite and a little zinc blende, galena, pyrrhotite and pyrite; from this band, some spectacular specimens of copper ore may be taken.

In the remaining 21 feet, the crosscut passed through gneiss of which only one or two very narrow seams were characterized by the presence of a few grains of the sulphides.

Forty-five feet from the shaft, a winze, 56 feet in depth, on a slope of 70° was sunk with the intention of following the band of gneiss that contains chalcopyrite. At first the dip of the gneiss was 55° toward the southeast but at a depth of 25 feet it had decreased to 30° and forty feet down it flattened to 15°. Beneath this roll in the gneiss, the winze passed into a heavy band composed chiefly of flakes of phlogopite with actinolite and quartz and containing a few widely scattered grains of zinc blende, galena and chalcopyrite.

From the bottom of the winze, a crosscut was extended for 95 feet toward the east. For 19 feet, it passed through the greasy phlogopite-actinolite band and then penetrated a compact granular quartz vein, five feet in thickness. Beyond this quartz vein, the crosscut passed into the dark grey gneiss, dipping from 35° to 50° toward the southeast. Sixty-two feet from the winze, a mineralized bands of the gneiss was encountered, which with characteristic irregularity varied from a few inches to two feet in thickness. To be northeast and southeast, drifts were extended for 90 and 50 feet, respectively, until the ore had pinched out. For a few feet or yards along the strike, the ore occurs as a definite vein of black zinc blende with a little galena, pyrrhotite and occasionally grains of chalcopyrite; for longer distances the gneiss contains scattered grains and is traversed by narrow stringers of these sulphides. Within the remaining 33 feet of the crosscut, the gneiss is essentially barren, although in a very few places, scattered grains of zinc blende and galena may be found upon some of the planes of foliation.

About 220 feet to the southwest of the shaft within which the above work has been done, there is another vertical shaft, which in 1914 was sunk to a depth of 34 feet. When the property was examined, the shaft contained water, but it appears to have been sunk upon the crest of a "roll" in the gneiss, the dip here being 10° to 20° toward the southeast. It is said that the shaft penetrated several veins and streaks of ore which were similar in character to those already described.

On lot 43, several openings have been made which show that the gneisses are locally impregnated with a few disseminated grains of zinc blende and galena, but no discoveries have as yet been made that would warrant the sinking of a shaft.

The Montauban Mining Syndicate has not shipped any ore. For the most part, rock and ore have been accumulated together in the dump, while they have been looking forward to the construction of a concentrating mill. By handpicking the dump and including the ore that has been placed in sacks and on the floor of the shaft-house, it is probable that about twenty-five tons of high-grade zinc ore, carrying a few per cent of lead, could be sent to market. Sufficient ore has not been developed to warrant the erection of a mill.

Block C, Range II, S.W., Montauban.—Block C is almost completely covered with a heavy blanket of stratified sands and clays. Close to its boundary with lot 43, range I, S.W., a few small outcrops of the paragneisses appear in the bed of a small stream, and, for a few yards to the southeast of this stream, the bed rock lies near the surface. On a line corresponding to the continuation of the mineralized zone upon which the shafts of the Montauban Mining Syndicate, on lot 44, have been sunk, a few shallow excavations, from six inches to two feet in depth, have been made to bed rock.

One opening, seven feet from the boundary with lot 43, has disclosed a quartzose vein in the paragneiss, from eighteen inches to two feet in width, which is rich in zinc blende and galena. The gneisses are striking N 32° E and dipping steeply toward the southeast.

Thirty feet toward the northeast, in the direction of the strike, another opening displays the presence of two similarly mineralized veins or bands, one of which is three feet in width, and separated by eighteen inches of barren gneiss from another band, a foot in width, which carries much galena and zinc blende. One or two small blasts of dynamite have been discharged in the bed-rock.

About 40 yards further towards N. 32° E, the sand has been removed and similar paragneisses have been exposed but no mineralization is in evidence. In this distance of 40 yards, the strike has changed to N 12° E; hence in searching for a possible continuation of the mineralized bands, one should strip the bed rock for a few yards toward the northwest.

Thirty-five yards towards N 12° E and close to the small brook mentioned above, the gneiss, for a width of three feet, is traversed parallel to the strike, which has changed to N 22° E, by numerous small barren quartz stringers, none of which exceed three inches in width. To the northeast, in the direction of their strike, these gneisses then pass beneath a very heavy covering of stratified sands and clays for a distance of approximately a quarter of a mile when they form the low rocky mound which is situated less than two hundred yards from the Batiscan river below Chute No. 8 and close to the south of the old waggon road that here passes across Block C to the Seigniory of Price. On the summit of this mound, two

small openings in bed rock, the largest of which is three feet in depth, show the gneiss to be traversed by irregular stringers of quartz. Both the veinlets of quartz and the gneiss adjacent to them contain abundantly disseminated grains of pyrrhotite and a few of zinc blende.

That portion of Block C in the vicinity of the openings near the boundary with lot 43 is sufficiently promising to be worthy of further prospecting work. Stripping will undoubtedly reveal a zone of the gneiss enclosing irregularly lenticular veins of galena, zinc blende and quartz that both along the strike and with depth will prove to pinch and swell in a very irregular manner.

Continuation of this Mineralized Zone to the North of the Batiscan River in Chavigny township.—Considerable prospecting work has been done in searching for a possible continuation of this mineralized zone to the north of the Batiscan river in Chavigny township. Numerous small openings have been made in rock outcrops along what corresponds roughly to the continuation towards the northeast of a line joining the shafthouses of the Zinc Company Limited and the Montauban Mining Syndicate. A very few grains of zinc blende and chalcopyrite together with more profusely scattered grains of pyrrhotite and pyrite have been found in a small opening on lot 18, range I, S.W., (approximately 600 yards from the river up lot line 17-18 and 100 yards to left) and in another opening on lot 8 of the same range (about 450 yards from the river up lot line 8-9 and 100 yards to right). Both of these openings are in paragneisses.

Apparently it was not observed by the prospectors that to the north of the river, the strike of the gneissoid rocks makes a broad sweeping curve from N 39° E at Chute No. 8 to N 72° E on the northwestern end of lot 10, range I, S.W. Moreover, numerous small intrusions of fine-grained and intensely foliated granitoid gneiss have repeatedly interrupted the paragneisses, or, locally changed their strike.

What would appear to be at least a portion of the zone sought for was discovered toward the northwestern end of lot 10, range I, S.W. Its position is shown on the accompanying map. Here, a

massive band, which is almost entirely composed of tremolite, quartz, and small amounts of pyroxene and calcite, possesses a maximum width of twenty feet and is intercalated between highly altered quartzites. The location of this band may readily be approached by observing an outcrop of sheared white quartzites to the left of the bend in the road leading to Lac-au-Sable just prior to where the road follows the line between lots 9 and 10, range I, S.W. This outcrop is further distinguished by disseminated grains of pyrrhotite together with a very few grains of chalcopyrite in the quartzite, and by the presence of tremolite on some of the planes of foliation. If the strike of these quartzites be followed up the hill to the left, the tremolite-rich band will be located.

Within portions of this band of highly altered impure magnesian limestone, grains of pyrrhotite are abundantly disseminated. A very careful search also revealed the presence of a very few particles of chalcopyrite, two or three grains of zinc blende and a few small flakes of molybdenite. A few samples composed of tremolite and quartz, impregnated with pyrrhotite were submitted to the Provincial Laboratory, Ecole Polytechnique, Montreal, where on assay they yielded 20 cents per ton in gold.

None of the discoveries that have been made to the north of the Batiscan river within this area are of the least commercial importance.

The Laurentide Mining Company.—Lot 6, range V, S.W., and lot 7, range IV, S.W., Montauban township.

Prospecting work has also been done on the southeastern end of lot 7, range IV, S.W., and on the adjacent portion of lot 6, range V, S.W., of Montauban township, by the Laurentide Mining Company which includes at least some of the leading members of the Montauban Mining Syndicate. To the south of the village and about two miles and a half from Notre Dame des Anges railway station, these prospects are situated, just beyond the crest of a ridge chiefly composed of massively bedded white quartzites that here form the margin of the higher land that one encounters in ascending from the sandy terraces of the valley of the Batiscan river. That mineralization which has taken place is confined to a zone of quartzose-biotite gneisses, that lies between the white quartzites and the contact of the batholith of gneissoid granodiorite which occupies a

wide area toward the south and east. The quartzose biotite-gneisses enclose a few narrow bands, up to eight inches in thickness, that are almost entirely composed of biotite. Intercalated between the beds of white quartzites are sillimanite-bearing and garnetiferous biotite-gneisses which, in common with the quartzose biotite-gneisses, are the highly metamorphosed equivalents of what originally were feldspathic and argillaceous sandstones. Here, these metamorphosed sedimentary rocks strike N 10° E and dip 30° to 50° to the southeast beneath the margin of the body of granodiorite. They are traversed by a few dykes of light grey gneissoid granite, that, attaining a few yards in width, trend parallel to the strike. Locally, they are also intersected by small ramifying dykes of aplite and pegmatite.

Two shafts have been sunk upon this property. Since 1914, the prospecting has been discontinued, and both shafts were full of water. In the southwestern corner of lot 6, range V, S.W., a vertical shaft (No. 1) has been sunk to a depth of 30 feet. Disseminated grains of zinc blende, galena, pyrite and pyrrhotite were present upon a few of the planes of foliation and within two or three very narrow stringers of quartz. About 160 yards southeast of the line between ranges IV and V, S.W., and either on or very close to the boundary between lots 7 and 8, a shaft (No. 2) has been sunk to a depth of 62 feet on a slope of about 40 degrees. At the bottom of the shaft, a crosscut, 15 feet in length, was driven toward the northeast. Eastward from the shaft and at a distance of 170 feet, at right angles to the strike, the contact of the batholith of granodiorite is situated. At the shaft, the quartzose biotite-gneisses are somewhat contorted along the strike. The shaft is said to have been sunk upon a band of the gneiss which, for a thickness of four feet, was traversed by irregular lenticular veins of black zinc blende with a small amount of pyrite and pyrrhotite and a very few grains of galena and chalcopyrite. The individual veins are said to have been very variable in width. At a certain stage in the deepening of the shaft, a vein of almost solid zinc blende would possess a thickness of from one to two feet; a few feet farther down, this would be replaced by grains of the metallic sulphides disseminated along certain of the planes of foliation of the gneiss and within narrow stringers of quartz, trending parallel to the foliation. At the surface, exposures of the gneiss, in strike with and

immediately adjacent to the shaft, enclose only a few very narrow and irregular seams of the sulphides; within a few feet along the strike, only widely scattered grains of the sulphides are present.

No ore has been shipped from the property. Mr. E. J. Thibault informed me that from shaft No. 2, nine or ten tons of hand-picked zinc ore of a good grade were placed in sacks and stored in a small building near the shaft house.

Lot 8, Range IV, S.W., Montauban Township.—Sixty-five feet from shaft No. 2 of the Laurentide Mining Company and on the same mineralized zone, a shaft was sunk, during July and August, 1915, to a depth of 26 feet on a slope of 40 degrees toward the east. A band of the gneiss, with a maximum width of 15 inches, contains some grains of black zinc blende and pyrite that are disseminated parallel to the foliation.

Sixty feet farther southward along the strike, where the rock exposures descend to the low soil-covered land that borders a small lake, an opening four feet deep has been made. The gneiss contains a few very widely scattered grains of zinc blende, pyrite and chalcopyrite.

Lac au Sable Magnetite Deposit, Range III, S.W., Lots 20 and 21, Chavigny Township..—On the northern shore of the western end of Lac au Sable, and about a mile and a quarter from the Canadian Northern Railway station bearing the name of this lake, some prospecting work has been done. The hill that here rises steeply from the lake is composed of granitoid gneiss intrusive into amphibolites and a small remnant of crystalline limestone. The gneissoid granite adjacent to the limestone is light grey in colour and intensely foliated. In thin section under the microscope, it is found to be composed of microcline, quartz, green hornblende, biotite, epidote, sphene, numerous small grains of magnetite and pyrrhotite and a few minute crystals of zircon and apatite. The microcline comprises more than three-fourths of the rock. Some of the quartz is micrographically intergrown with the microcline, and both of these minerals display strain shadows.

The amphibolites have apparently been developed by the extreme metamorphism of Grenville limestones, during the invasion of the gneissoid granite. There remains only a small ragged remnant of coarsely crystalline limestone which, in massive beds, with a total maximum exposed thickness of 15 feet, outcrops at intervals for approximately 200 feet along the strike. Some of the more coarsely crystalline calcite in the limestone is of a delicate azure-blue colour. Through processes of contact metamorphism, the limestone has been altered to a compact rock of dark green colour, which consists of diopside, garnet and epidote with a few grains of magnetite, pyrrhotite and pyrite. Small grains and crystals of epidote and garnet are also abundantly scattered through portions of the crystalline limestone. Some well-formed crystals of epidote attain a length of three inches.

Locally, the limestone has been chiefly replaced by magnetite and pyrrhotite together with a few grains of pyrite, chalcopyrite and an occasional small crystal of arsenopyrite. Two small open cuts, one near the margin of the lake, and the other on the side of the hill about 50 feet above the lake, have not disclosed anything of economic value. Because of the sulphur content of the associated sulphides, pyrrhotite, pyrite and chalcopyrite, the comparatively small deposits of magnetite that have been exposed are useless as a source of iron ore.

Although some specimens may be collected that would contain a few per cent of copper, the average copper content of the deposits would not exceed a small fraction of one per cent.

PROSPECTING

The discovery of these deposits of zinc blende and garnetiferous galena in the vicinity of Notre Dame des Anges should stimulate prospecting in adjacent districts. Experience has taught that it is useless to prospect for ore deposits of value within the widespread areas occupied by the gneissoid granites and granodiorites. Attention should be devoted to those areas underlain by rocks into which the granites and granodiorites are intrusive. Undoubtedly, within widespread areas adjacent to the ore described in this report,

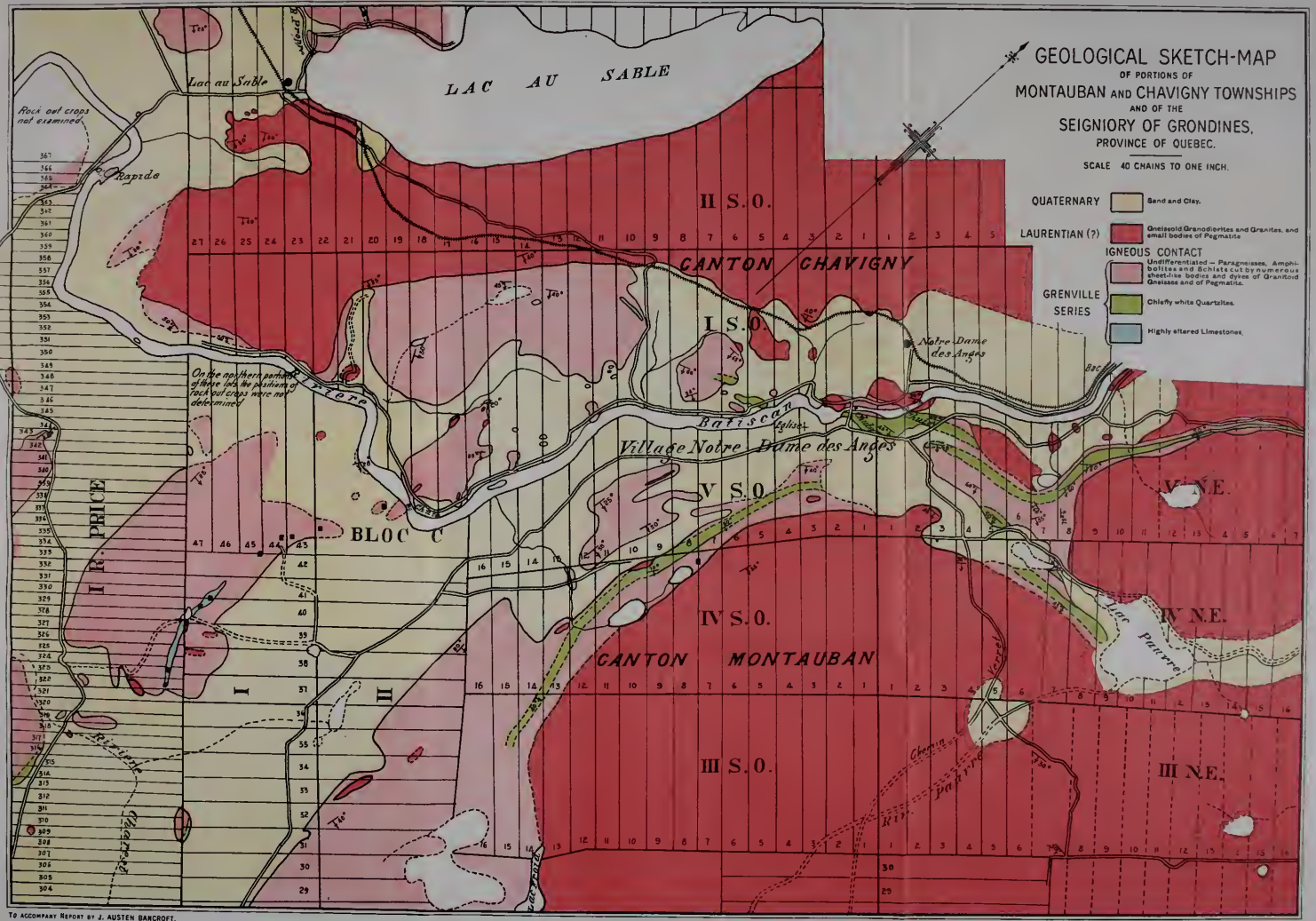
there are numerous small, and possibly some extensive, areas where remnants of the highly metamorphosed stratified rocks of the Grenville Series are present. These rocks, and especially any altered limestone bands that they may include, should be carefully examined in the hope of discovering valuable minerals. Prospecting endeavour should not be restricted to a search for zinc blende and galena, because from analogy with other areas farther southward, where the Grenville Series has been more thoroughly prospected, it is possible that deposits of graphite, magnetite, pyrite, apatite, "amber "mica, barytes, magnesite, talc, and possibly some quartz veins carrying gold may be found.

ALPHABETICAL INDEX

	Page
Abitibi, copper in	27
Accidents, analyses of	70, 72
Accidents—table of fatal	77
Actinolite	126
Adams, F. D	118
Adams, L. D	129
Algoman granite	110
Amherst township, Kaolin	39
Amphibolites	117
Andradite	127
Anorthite	126
Apatite	127
Arsenopyrite	126
Artesian wells in Montreal	45
Asbestos and Asbestic Company The, improvements	24
Asbestos Corporation of Canada improvements	22
Asbestos industry, table showing development of	21
Asbestos, in other countries	26
Asbestos—production of	19
Bancroft, Dr. J.-A, work of	15
Bell Asbestos Mines Co. improvements	25
Bigot, Dr. A., experiments of, on Kaolin	42
Black Lake Asbestos and Chrome Co. Limited, work at	25
Blende	126
Bounty on zinc	31
Canada Paint Company, plant of	32
Chalcopyrite	134
Chavigny Tp	138
China stone in Amherst Township	40
Coleraine Township, Chrome of	53
Cordierite-gneisses	118
Cummings, C. L., on Artesian wells of Montreal	45
Dalquier Township, copper in	28
Dasserat Township, gold in	28
Denis, T. C	4, 105
Diopside	125
Dulieux, P.E., Report by	32
Ells, R. W., work of	104
Eureka Flint and Spar Co., work of	38
Eutis Mine, Development	26
Explosives	14
Exports, restrictions	17
Forbes and Campbell, work of	36
Frechette, Howells, work of, on limestones	16
Galena	124
Garnets	119
Gaspé, galena and blende in	30
Gauthier, Elzear,	103, 128
Gedrite	118
Geology, economic	124
Geology of Montauban Tp	108
Gneisses	115
Gold at Notre Dame des Anges	28
	128, 131
Graham, R.P.D., determination by	127
Granites in Montauban	120
Granite quarries in Quebec	46
Granodiorites	120
Graphite	116, 127
Grenville magnesite, analyses	43
Grenville series	110, 114
Grenville township, magnesite in	42
Grondines	117
Hood's mountain	105
Injured—age of	74
Jacobs Asbestos Mining Co., improvements	24
Kaolin as a paper filler—tests	40
Keele, J., laboratory work on kaolin by	41
Lac-au-Sable magnetite deposit	141
Lac-au-Sable	118
Lac Pauvre, granite	120

	Page
Laurentide Mining Company.129,	139
Lead	131
Leda Clay	113
Limestones	120
Limestones, investigation of Quebec	16
Limestones quarries around Montreal	46
Lorraine shales in St. Hyacinthe	48
Low, A. P., work of	104
Magnesite, uses	44
Magnesium-maufactured in Quebec	44
Magnetite deposits	141
Manitou Iron Mining Company	32
Marbles of Province of Quebec	47
Martin-Bennett Asbestos Mines Limited	25
McKune, F. L., experiments with Magnesite	43
Men in the mining industry	68
Mica—prices	39
Mining rights amended	10
Molybdenite in Montauban	126
Molybdenite, concentration of	37
Montauban, Blende and Galena	29
Montauban, field work in	14
Montauban Mining Syndicate	30
.....129,	133
Muscovite	124
Mutual Chemical Company of Canada, mills of	36
New Richmond Prospecting and Mining Co., Limited	30
Notre Dame des Anges, altitude	107
Notre Dame des Anges, location of	103
Orford township, chrome in	35
Palaeozoic rocks	112
Paragneisses	125
Pleistocene period	112
Preissac Township, molybdenite in	36
Price Seigniory, Blende and Galena	124
Prospecting	142
Publications of bureau of mines in 1915	15
Pyrrhotite	119
Quartzites.....111,	114
Regulations, new	14
Rutile	119
Safety first work	72
Sand, investigation of Quebec	16
Sandstone quarries	46
Saxicava Sand	113
Scaling of workings	14
Scapolite	126
Sillimanite gneiss	116
Silver	131
Slate, New Rockland quarry	46
St. Barnabé gas field	47
St. Gérard mine	27
Stairs	76
Tariff—Government assay Laboratory	139
Tétreault mine	29
Tétreault, Pierre	128
Tétreault's property	129
Thibault, E. J.	134
Topography of Montauban Tp	105
Tremblay, Joseph, discovery of	27
Tremolite	125
Weedon Mining Company	129
Weedon mine development	27
Wilsonite	126
Windsor Asbestos Company	20
Wotton Asbestos Company	20
Wright mine, unwatering of	30
Zinc blende	128
Zinc, occurrences	124
Zinc Company Limited.....129,	130
Zircon	117

PROVINCE OF QUEBEC, CANADA.
DEPARTMENT OF COLONIZATION, MINES AND FISHERIES
MINES BRANCH



To accompany Report by J. Austen Bancroft.

ENGIN STORAGE